DOCUMENT RESUME

ED 218 430 CE 031 220

AUTHOR	Bacon, E. Miles
TITLE	Engine Tune-up Service. Unit 6: Emission Control Systems. Student Guide. Automotive Mechanics Curriculum.
INSTITUTION	Florida State Univ., Tallahassee. Career Education Center.
SPONS AGENCY	Florida State Dept. of Education, Tallahassee. Div. of Vocational Education.
PUB DATE	Mar 78
NOTE	204p.; For related documents see CE 031 208-222 and CE 033 108-109.
EDRS PRICE	MF01/PC09 Plus Postage.
DESCRIPTORS	*Auto Mechanics; Behavioral Objectives; *Engines; Instructional Materials; Learning Activities; Postsecondary Education; Secondary Education; Study Guides; *Trade and Industrial Education
IDENTIFIERS	*Automotive Tune Up; Emission Control; *Emission Control Systems

ABSTRACT

This student guide is for Unit 6, Emission Control Systems, in the Engine Tune-Up Service portion of the Automotive Mechanics Curriculum. It deals with inspecting, testing, and servicing an emission control system. A companion review exercise book and posttests are available separately as CE 031 221-222. An introduction tells how this unit fits into the total tune-up service, defines new terms, and provides work activities on the introductory information. Seven performance objectives are covered: perform operational inspections of positive crankcase ventilation system; perform operational inspection of fuel evaporative emission control systems; inspect, test, and service thermostatic air cleaner systems; inspect, test, and service air injection systems; inspect, test, and service exhaust gas recirculation systems; inspect, test, and service ignition timing control systems; and test exhaust performance, using hydrocarbon-carbon monoxide tester. Each objective is addressed in a separate section that includes these materials: introduction to the performance objective, performance checklist, list of tools and equipment needed to do the work activities for this performance objective, reading list, information sheets, and work activities that give hands-on practice in doing one part of the performance objective. (YLB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED218430

ENGINE TUNE-UP SERVICE

Unit 6: Emission Control Systems

Student Guide

Automotive Mechanics Curriculum

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

David McOuat

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

State of Florida
DEPARTMENT OF EDUCATION
Ralph D. Turlington, Commissioner of Education
Tallahassee, Florida

An equal opportunity employer • *Division of Vocational Education* • March, 1978

CE031220

Written by: E. Miles Bacon

THE AUTOMOTIVE MECHANICS CURRICULUM TEAM

Team Leader: Roger L. Richardson
Instructional Designer: Ludy Goodson, Roger L. Richardson
Measurement and Evaluation Specialist: David Morse
Automotive Mechanics Curriculum Design Specialist: E. Miles Bacon
Subject Matter Specialist: Theodore R. May
Field Test Editor: Kathleen Lyons
Final Production Editor: Marie Foster
Graphic Designer: John S. Matlock
Librarian: Marsha Paddock

CAREER EDUCATION CENTER, FLORIDA STATE UNIVERSITY

Director: Robert L. Lathrop
Information Services Division Coordinator: Margaret Winkler
Production Division Coordinator: Mary Anne Kidd
Editorial Division Coordinator: Dolores Filson
Visual Communications Division Coordinator: Lynn Rogers
Diffusion and Dissemination Division Coordinator: Mary K. Price
Art Director: William J. Kidd

PRODUCTION

Proofreading and Traffic Supervisor: Ann Vente
Proofreaders: Alice Lawyer, Susan Fleming, Becky Goff
Art Production Supervisor: Bob Burgun
Production Assistants: Hollis Bliss, Dan Haskin
Illustrators: Julian Key, Cheryll McMahon Frank, Robert Swanson
Copy Staff: Sylvia Finkell, Agnes Padgett, Betty Willard

CONTENTS

Acknowledgments vii
How to Use This Book vii
Introduction to Unit 6 1

Performance Objective 33: Perform Operational Inspections of the Positive Crankcase Ventilation System 9
Introduction 11
  Personal and Service Safety Practices 12
Procedures for Inspecting and Testing the PCV System 12
  Visually Inspecting the PCV System 13
  Testing the PCV System 14
    Work Activities 18
Servicing the PCV System 19
    Work Activities 23

Performance Objective 34: Perform Operational Inspection of Fuel Evaporative Emission Control Systems 25
Introduction 27
  Personal and Service Safety Practices 28
Inspecting the Fuel Evaporative Emission Control System 29
  Inspecting the Fuel Tank 30
  Inspecting the Vapor Vent Lines, Hoses, and Vapor-Liquid Separators 30
  Inspecting the Three-Way Control Valve 33
  Inspecting the Pressure-Vacuum Filler Cap 34
  Inspecting the Fuel Vapor Storage (Charcoal Canister) 35
    Work Activities 39
Servicing the Fuel Evaporative Emission Control System 39
  Replacing Vapor Vent Hoses 39
  Replacing the Three-Way Control Valve 40
  Replacing the Pressure-Vacuum Filler Cap 41
  Replacing the Canister Filter Element 42
    Work Activities 44

Introduction to Exhaust Emission Control Systems 45

4

Performance Objective 35: Inspect, Test, and Service Thermostatic Air Cleaner (TAC) Systems 47
Introduction 49
Operation of the GM and Chrysler TAC 51
Inspection and Testing of the GM TAC 52
Servicing the GM TAC 54
    Work Activity 56
Inspecting and Testing the Chrysler-made TAC 57
Servicing the Chrysler-made TAC 59
    Work Activities 61
Operation of the Ford/AMC-made TAC 61
Inspecting and Testing the Ford/AMC-made TAC 63
Servicing the Ford/AMC-made TAC 67
    Work Activities 69

Performance Objective 36: Inspect, Test, and Service Air Injection Systems 71
Introduction 73
Inspecting and Testing the Air Injection System 77
    Work Activities 86
Servicing an Air Injection System 86
    Work Activities 94

Performance Objective 37: Inspect, Test, and Service Exhaust Gas Recirculation (EGR) Systems 95
Introduction 97
Types of EGR Systems 99
Operation of the EGR System 103
    Work Activity 104
Inspecting and Testing the EGR System 105
  EGR Coolant Control Valve Test 108
  EGR Valve Test 109
  Carburetor EGR Port Test 110
  Venturi Vacuum Amplifier Test 110
Other EGR System Vacuum Control Devices 112
    Work Activities 115
Servicing the Exhaust Gas Recirculation System 116
  Floor Jets 116
  Vacuum Hoses 117
  EGR Coolant Control Valve 118

EGR Valve 119
Carburetor Vacuum Ports 121
Venturi Vacuum Amplifier 121
EGR Maintenance Reminder System 122
Work Activities 124

Performance Objective 38: Inspect, Test, and Service Ignition Timing Control Systems 125
Introduction 127
Transmission Controlled Spark (TCS) System 129
Components of the Transmission Regulated Spark (TRS) System 129
Summary of the Ford TRS System Operation 131
Work Activity 132
Preliminary Tests of the Transmission Controlled Spark (TCS) System 132
Work Activities 136
Testing the Ford TRS System 136
Testing the Ford TRS Components 138
Other TCS Systems and Components 141
American Motors Corporation 141
Chrysler Corporation 142
General Motors Corporation 143
Work Activities 146
Electronic Spark Control (ESC) System 146
Summary of the Ford ESC System Operation 149
Work Activity 150
Testing the ESC System 150
Testing the Ford ESC Components 153
Work Activities 157
Ford Temperature Activated Vacuum (TAV) System 157
Work Activities 162
Ford Cold Temperature Activated Vacuum (CTAV) System 162
Work Activities 168
Chrysler Orifice Spark Advance Control (OSAC) System 168
Work Activity 173
Chrysler Thermal Ignition Control (TIC) Valve 173
Work Activity 177

Performance Objective 39: Test Exhaust Performance, Using the Hydrocarbon-Carbon Monoxide (HC—CO) Tester **179**
Introduction **181**
Testing Exhaust Performance with Hydrocarbon-Carbon Monoxide (HC-CO) Tester **184**
Interpreting Emission Tester Readings **187**
Summary of Emission Test Results **190**
    Work Activities **191**
Carburetor Idle Adjustment **191**
Testing Other Emission Control Systems with the HC-CO Tester **192**
    Work Activities **196**
Experimental Testing with the HC-CO Tester **197**
    Experimental Tests 1-7 . . . . **201**

The Tune-Up Service **203**
Engine Performance Testing and the Diagnosis of Engine Malfunctions **203**
Adjustment, Repair, or Replacement of Defective Parts . . . **205**
    Work Activity **206**

ACKNOWLEDGMENTS

Developing and field-testing the units in *Engine Tune-Up Service* has been a mammoth task. Without the help of many individuals who generously contributed their time and knowledge, such an endeavor would not have been possible.

The Automotive Mechanics Curriculum Team is particularly indebted to its advisory committee: E. Miles Bacon, Consultant for Industrial Education, Region II; Martin Nelson, Pinellas Vocational-Technical Institute; Joe Hamlett, American Motorcycle Institute; Peter Mathey, Sarasota Vocational-Technical Center; Arthur Ballou, Director of Industrial Education for Dade County; and William Schipper, Ford Motor Company.

The team would also like to express its thanks to the instructors who tested Unit 6 in their vocational classrooms: Vernon Crotts and Jerry Bush, Lively Area Vocational Technical Center (Leon County). A special thanks goes to the principals and administrators who allowed us to field-test our materials in their schools.

Other individuals who contributed to the publication of this book include Kathleen Lyons and Eleanor Feltser, who did the editing for the field-test version of Unit 6.

HOW TO USE THIS BOOK

As you work through this Student Guide, you'll find directions about when to do certain activities and when to use the Review Exercise Book. Be sure to follow these directions carefully since they lead you step by step to the completion of a performance objective.

Performance Objectives

The performance objectives (abbreviated P.O.) in this Student Guide are statements of what you'll need to do on the job. All the materials in the Student Guide and in the Review Exercise Book are carefully designed to help you do well on performance objectives. So be sure to complete all the activities and try to do well on each activity.

After you have finished all the activities for a performance objective, your instructor will test you to see whether you have mastered the necessary skills. A performance checklist will be used to check your work.

WORK ACTIVITIES

You'll need to check with your instructor before and after doing any work activity. Automotive mechanics is a hazardous trade. That's why it's important for you and your instructor to be sure that you do the work activities safely. Each work activity gives you hands-on practice in doing one part of a performance objective. Do each work activity as required in the Student Guide, and you'll find it easier to do the complete performance objective later. Never hesitate to ask your instructor about something you're unsure of in a work activity.

Review Exercise Book

As you work through this Student Guide, you will frequently be directed to complete a pretest or an exercise in your Review Exercise Book. Before you begin the first pretest, read the introduction at the front of the Review Exercise Book. The introduction gives you information about how to use the book so that you'll get the most out of it.

Pretest

Before you go any further, ask your instructor whether you can take the first pretest for Unit 6. The pretest will let you know what to look for in these materials. If you do well on the pretest, your instructor may let you skip some of the study material in the Student Guide.

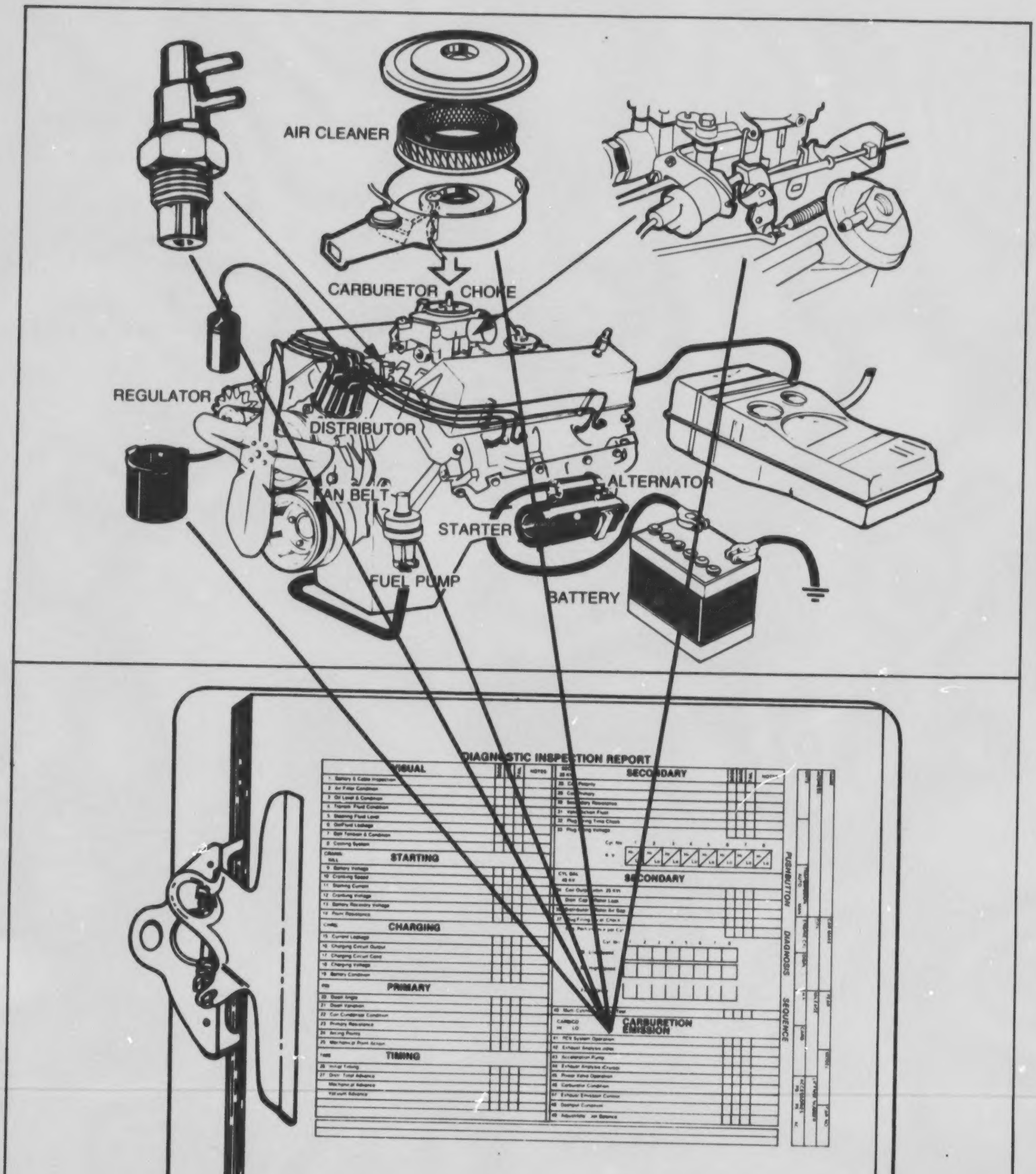
Your instructor will let you know when to begin studying the materials in this Student Guide.

Good luck!

INTRODUCTION TO UNIT 6

The last step in the total tune-up service is inspecting, testing, and servicing emission control systems and components (see figure I-1). Since the early 1970s, American cars have had emission control systems that cut down the amount of pollutants released into the air. As more testing was performed on these emission control systems, more complicated systems were developed.

Today there are several types of emission control systems for American-made cars in use. Some parts of these systems are in the exhaust system, while others are in the engine compartment or are connected to parts of the fuel system.

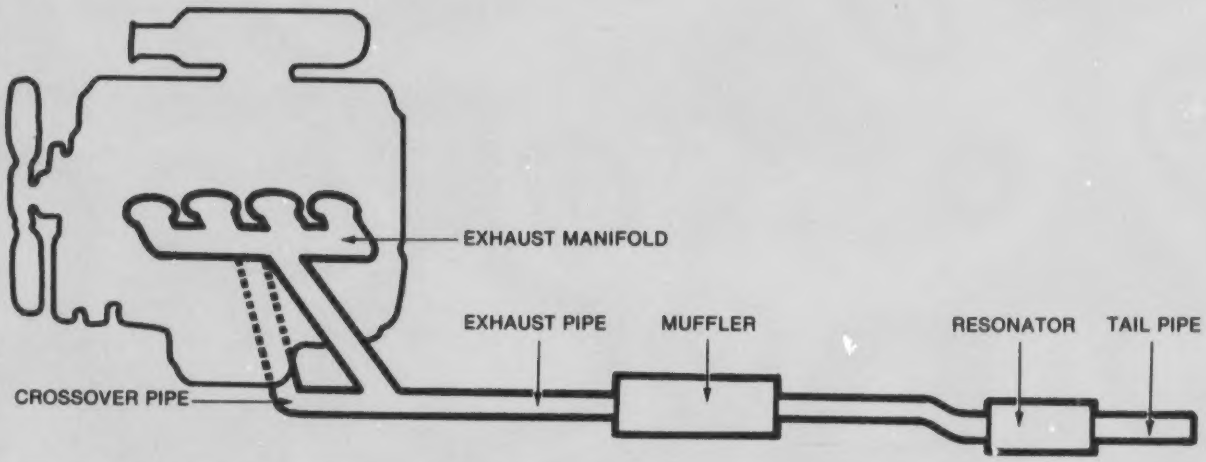

AIR CLEANER
CARBURETOR
CHOKE
REGULATOR
DISTRIBUTOR
ALTERNATOR
FAN BELT
STARTER
FUEL PUMP
BATTERY
DIAGNOSTIC INSPECTION REPORT
VISUAL
STARTING
CHARGING
PRIMARY
TIMING
SECONDARY
SECONDARY
CARBURETION EMISSION
PUSHBUTTON DIAGNOSIS SEQUENCE

Although the exhaust system is not part of the fuel and carburetion system, it is related to fuel and to carburetion. It helps to collect the burned gases expelled from the engine's cylinders and to send them to the emission control components or out into the air. The components of the exhaust system are:

- the exhaust manifold
- the manifold heat control valve
- the exhaust pipe
- the muffler
- the resonator
- the tail pipe

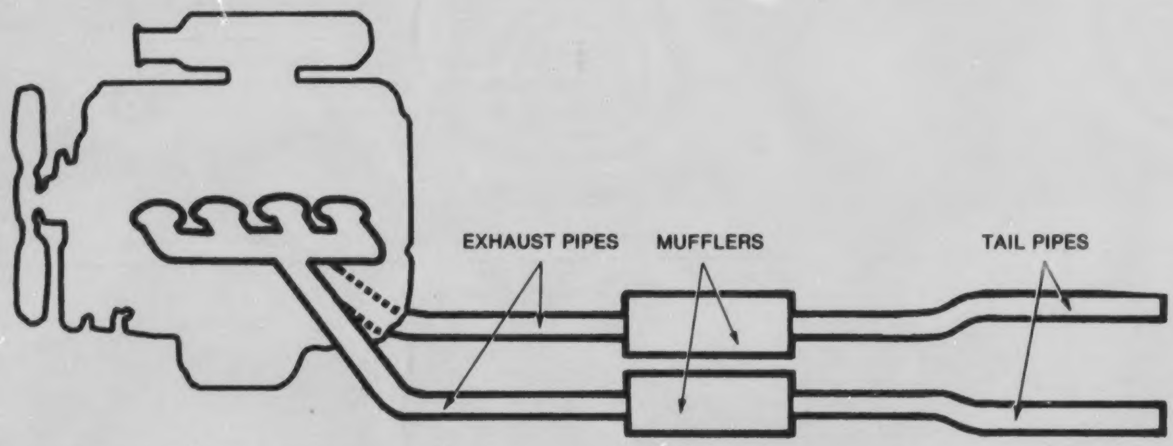
The components work together to channel the exhaust gases to the muffler, and then through the tail pipe into the air. Figure I-1 shows the basic components of the exhaust system.

Figure I-1 Single Exhaust System


EXHAUST MANIFOLD
EXHAUST PIPE
MUFFLER
RESONATOR
TAIL PIPE
CROSSOVER PIPE

There are two of each of the main components in a dual exhaust system. Figure I-2 shows a dual exhaust system.

Figure I-2 Dual Exhaust System



The crankcase, exhaust, and evaporative emissions that come from the fuel and carburetion system are controlled by different emission control devices, or pollution control devices, as they are also called. There are many different emission control devices, but there are only three main systems:

- the positive crankcase ventilation system (PCV)
- the evaporative emission control system (EEC)
- the exhaust emission control system (ECS)

The PCV (positive crankcase ventilation) system reduces emissions from the crankcase by sending them back to the engine's intake system.

The EEC (evaporative emission control) system works while the engine is turned off by storing the evaporation vapors in a canister or in the crankcase. When the engine starts, the vapors go to the engine for combustion.

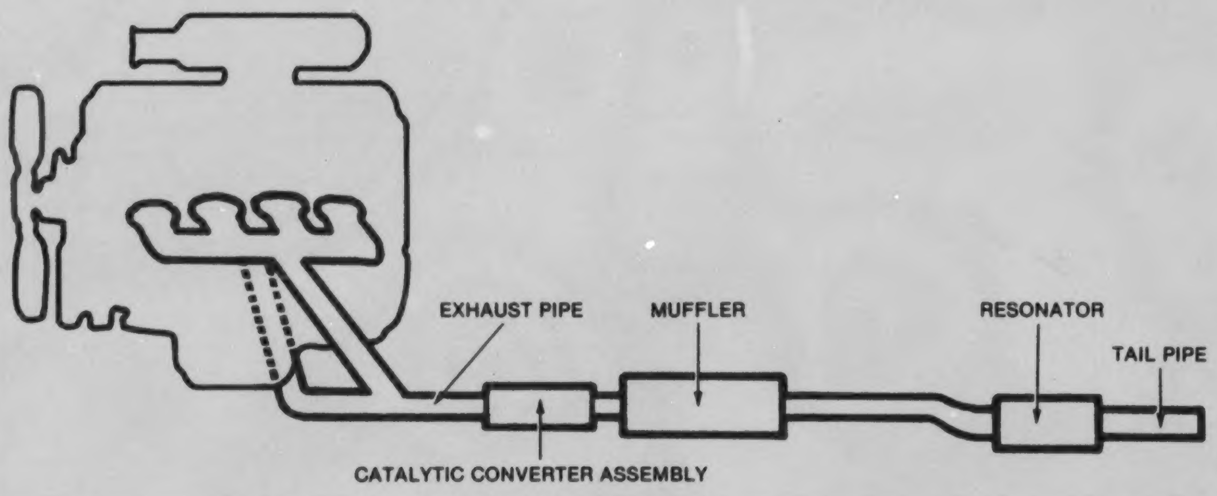
The ECS (exhaust emission control system) reduces exhaust emissions in any of four ways: by recirculating exhaust gases, by adding air to exhaust gases, by changing certain exhaust gases chemically, or by controlling the ignition timing.

Recirculating exhaust gases. The recirculation of exhaust gases gives the gases a second burning and lowers the combustion temperatures. This in turn reduces the amount of nitrogen oxide emission. The exhaust gas recirculation system is simply called an exhaust gas recirculation system or EGR system.

Adding air to exhaust gases. When injected air is mixed with such exhaust gases as hydrocarbons and carbon monoxide, it makes these chemicals burn more completely. This reduces the amount of such pollutants entering the air. One type of air injection device is called an air injection reactor or AIR.

Changing exhaust gases chemically. Exhaust gases can be sent through chemical compounds that change hydrocarbon emissions into water and the carbon monoxide emissions into carbon dioxide. One type of chemical device that promotes these chemical changes is called a catalytic converter (see figure I-3).

Figure I-3 Exhaust System with Catalytic Converter



Controlling the ignition timing. Ignition timing can be controlled in ways that make the air-fuel mixture burn more evenly. Certain systems have been developed that control or delay the spark advance under certain conditions. These systems can be controlled by temperature, vehicle speed, transmission selection, or throttle opening. The control and operation of each system differ from manufacturer to manufacturer, but all delay or control the vacuum advance of the ignition. Throughout Unit 6, these systems are called ***ignition control systems.***

Tools and Equipment

You will need to use the following tools and equipment when you do the work activities for Performance Objectives 33 through 39 in this unit. You should already be able to use a basic hand tool set, so no procedures are provided here. The procedure for using special tools and equipment, however, will be provided as you work through the activities in this Student Guide.

Basic Hand Tool Set

Special-Purpose Hand Tools

flashlight
hose-clamp pliers
carburetor adjusting tool

Basic Equipment

1/4 inch electric drill
drill bit set
air thermometer
hand vacuum pump
vacuum-pressure gauge
fender covers
extension light
belt tension gauge
inch-pound torque wrench
foot-pound torque wrench
timing light
dwell tachometer
hydraulic jack
jack stands
continuity light
ohmmeter
water thermometer
compressed air hose
compressed air blowgun

Safety Equipment

eye protection

Special Equipment

PCV tester
hot plate
steel bridge
gear puller
hydraulic lift
exhaust performance analyzer HC-CO

engine analyzer
oscilloscope

READING LIST

The Student Guide has been carefully designed to provide you with only the information you need to know to complete each performance objective. If you would like additional information, however, you may wish to use the references below.

General References

Crouse, William H. ***The Auto Book.*** New York: McGraw-Hill, Inc., 1974, pp. 301-318, 352-353, 361.

Crouse, William H. ***Automotive Mechanics.*** 7th ed. New York: McGraw-Hill, Inc., 1975, pp. 160, 211, 216-217, 338, 345-346, 822.

Ellinger, Herbert E. ***Automechanics.*** 2nd ed. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1977, pp. 231-249, 341.

Stockel, Martin W. ***Automechanics Fundamentals.*** South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1975, pp. 106-118.

Stockel, Martin W. ***Auto Service and Repair.*** South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1975, pp. (17-11)-(17-14), (33-8)-(33-20).

Toboldt, William K. and Johnson, Larry. ***Automotive Encyclopedia.*** South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1975, pp. 237, 251-253, 271-279, 321-334, 473, 474.

Special-Purpose References

Crouse, William H. and Anglin, Donald L. ***Automotive Fuel, Lubricating, and Cooling Systems.*** New York, NY: McGraw-Hill, 1976, pp. 146-170, 194-196, 245-246.

Ellinger, Herbert E. ***Automotive Systems Fuel, Lubrication and Cooling.*** Englewood Cliffs, NJ: Prentice-Hall, 1976, pp. 24-37, 73-74, 106-122.

Before you begin reading in Performance Objective 33, read the instructions at the front of your Review Exercise Book.

PERFORMANCE OBJECTIVE 33

PERFORM OPERATIONAL INSPECTIONS OF POSITIVE CRANKCASE VENTILATION SYSTEM

INTRODUCTION

In this Student Guide, you'll learn how to inspect, test, and service the positive crankcase ventilation (PCV) system.

You may find it helpful to review Performance Objective 23, where you'll find information on cleaning and replacing the PCV filter located in the carburetor air cleaner. The PCV air filter is a part of the positive crankcase ventilation system.

After you have finished all the activities for Performance Objective 33, your instructor will use a checklist like the one below to evaluate your work.

PERFORMANCE CHECKLIST—P.O. 33

The instructor will provide either a live vehicle or a live engine for this objective. Perform an operational inspection of the PCV system and correct any problems you find. All of the performances below must be accomplished.

Student Performances	**Instructor Ratings**		
	Acceptable	Not Acceptable	Omit
1. Visually inspects PCV system parts. Corrects defects as necessary.			
2. Operationally tests PCV system, following the manufacturer's procedures.			
3. Cleans or replaces PCV system parts as necessary.			
4. Rechecks PCV system operation.			
5. Uses proper tools and equipment.			
6. Follows all appropriate safety precautions.			
7. Time.			

SAMPLE

Personal and Service Safety Practices

Safety when Working around the PCV System

- Always use fender covers when working under the hood. This will keep the fenders from getting scratched by belt buckles, tools, and equipment.
- Always store the carburetor air cleaner cover and filter element in a safe place, away from the vehicle, while you service PCV filters. Observing this safety practice will prevent crushing or damaging these parts.
- While the engine is operating, avoid reaching into the engine compartment without looking first. Your hand and fingers could get caught by moving parts.

Safety in Work Clothing and Grooming

Hair. Keep hair away from the moving parts of an operating engine. A severe injury can result. Keep your hair under a hat if it is longer than conventional length (reaches over your shirt collar).

Clothing. Avoid wearing loose clothing, which can hang down and get caught in the moving parts of an operating engine. Injury can result. Loose clothing can also catch on engine parts and tear.

PROCEDURES FOR INSPECTING AND TESTING THE PCV SYSTEM

Every vehicle manufactured since 1968 has a positive crankcase ventilation system. This system will be referred to as a ***PCV system*** throughout this performance objective.

A PCV system is one in which the ***blowby gases*** that enter the crankcase past the piston rings are directed back into the intake manifold and the engine for reburning (see figure 33-1). This system is also known as a ***closed crankcase ventilation system.*** In earlier engines, blowby gases in the crankcase were passed through a draft tube directly to the atmosphere.

Figure 33-1 illustrates how the PCV system works. Fresh air is drawn into the carburetor air cleaner and routed through a tube to the oil filler cap, which is sealed from outside air. The fresh air circulates through the crankcase and picks up the blowby gases, fumes, and condensation vapors. Engine vacuum at the intake manifold pulls the crankcase gases and fumes past a PCV valve into the intake manifold, and then into the combustion chamber where it is burned.

Figure 33-1 The PCV System

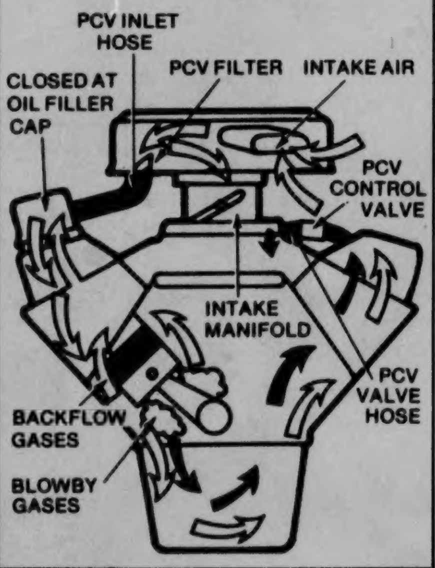


Figure 33-3 Visual Inspection Points in the PCV System

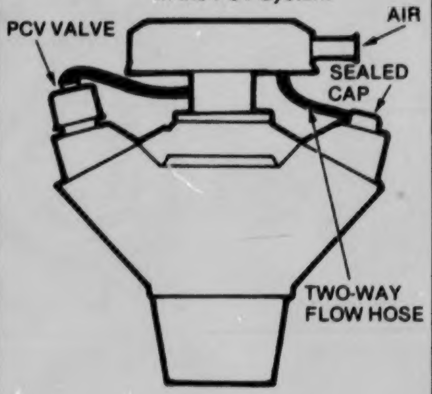


Figure 33-4 PCV Filter Element

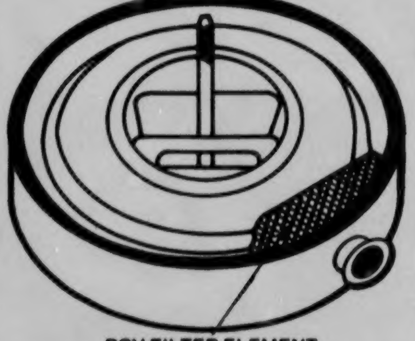
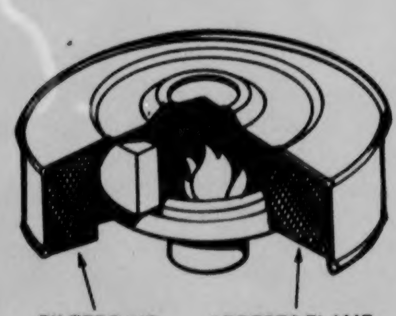


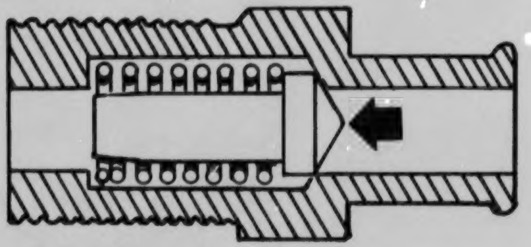
Figure 33-5 PCV Filter Filters Air and Arrests Flame



Notice that ***back flow*** gases can be drawn back into the air cleaner in case the PCV system becomes inoperative.

The PCV valve is located in the hose that leads to the intake manifold (see figure 33-2). The PCV valve meters the mixture of harmful gases into the intake manifold. There they are mixed with the air-fuel mixture. Then the gases are burned in the combustion chamber. Engine vacuum and changes in throttle opening control the PCV valve. Therefore the amount of metering that takes place depends upon engine vacuum and changes in the throttle opening.

Figure 33-2 Positive Crankcase Ventilation (PCV) Valve



Visually Inspecting the PCV System

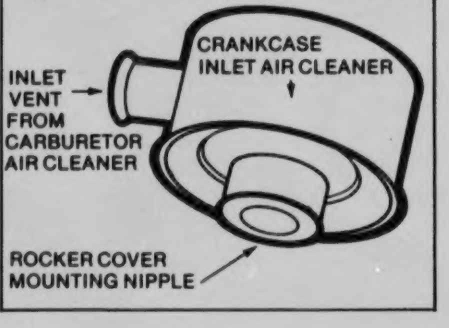
The PCV system should be visually inspected and tested at each tune-up, or every 12 months. The components and operation of the system must be in good working order.

Hoses. Check both the two-way flow hose and the intake manifold hose for cracks, kinks, and collapsed and loose connections (see figure 33-3). It is also recommended that you remove the hoses to ensure that they are free from clogs and sludge deposits.

PCV filter. Remove the top cover from the carburetor air cleaner and check the PCV filter element for dirt and clogging (see figure 33-4).

Both the PCV filter and the carburetor air cleaner serve as flame arresters. They prevent a crankcase explosion if a carburetor backfires (see figure 33-5).

Figure 33-6 Crankcase Inlet Air Cleaner


CRANKCASE
INLET AIR CLEANER
INLET VENT FROM CARBURETOR AIR CLEANER
ROCKER COVER MOUNTING NIPPLE

Crankcase inlet air cleaner. On some vehicles, there is a crankcase inlet air cleaner located on the engine rocker cover. It should be removed and cleaned. Servicing procedures for this cleaner are covered later in this performance objective (see figure 33-6).

PCV valve. Remove the PCV valve from the engine rocker cover by working the valve free from the rubber grommet. NOTE: Not all PCV valves are located in the rocker cover. Then shake the valve. If the valve is free, you should hear a metallic clicking sound. Be sure to check the grommet to see that it is free from cracks and deterioration (see figure 33-7).

Figure 33-7 Removing the PCV Valve

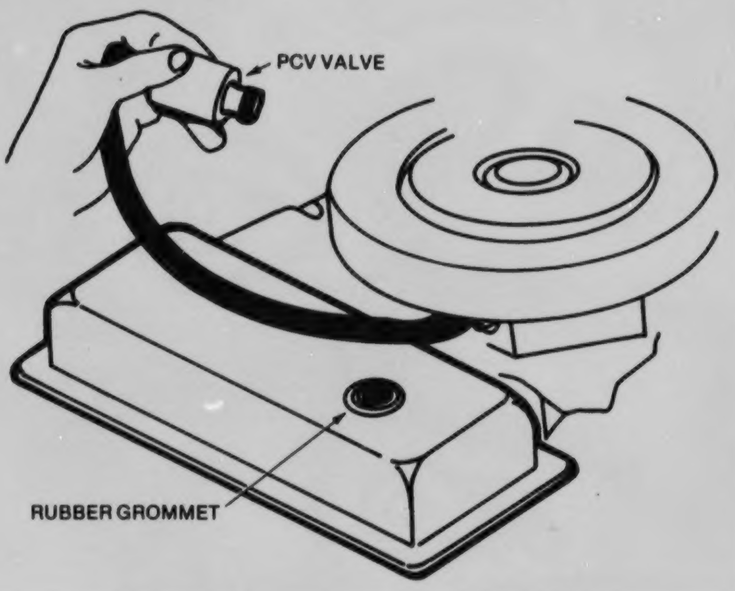
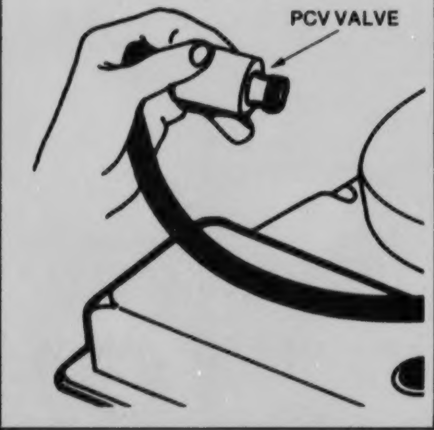


Figure 33-8 PCV Valve Removed



Testing the PCV System

There are several methods used to test PCV systems. Always refer to your technical service manual for the proper method and specifications recommended for the make, model, and year of the vehicle you're servicing. Here are a few of the testing methods.

Hand Method

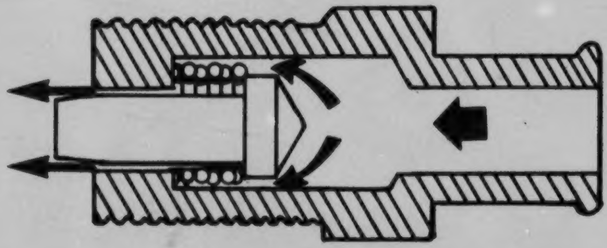
STEP 1 Operate the engine at normal curb idle and at normal engine operating temperatures. Remove the PCV valve from the engine rocker cover (see figure 33-8).

- You should hear a hissing noise as air passes through the valve. You should also notice an increase in engine RPM. The hissing and the RPM increase indicate that the valve is not plugged.

STEP 2 Place your finger over the valve inlet. You should feel a strong vacuum. This indicates that the valve is not plugged.

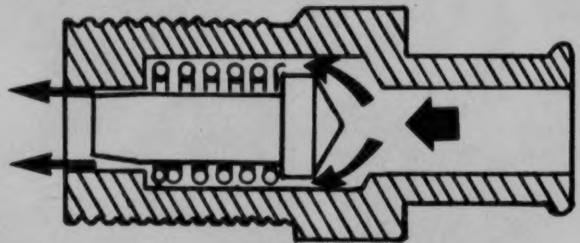
The PCV valve is controlled by engine vacuum. At idling speed, the vacuum is high, restricting the air flow. The PCV valve also prevents the high vacuum from pulling the oil out of the crankcase into the intake manifold (see figure 33-9).

Figure 33-9 PCV Valve: Idling or Low-Speed Operation (Vacuum High) Air Flow Restricted



During high-speed operation, the vacuum is low, crankcase vapor flow increases, and the PCV valve permits maximum air flow through the crankcase (see figure 33-10).

Figure 33-10 PCV Valve: Higher Speed Operation (Vacuum Low) Maximum Air Flow

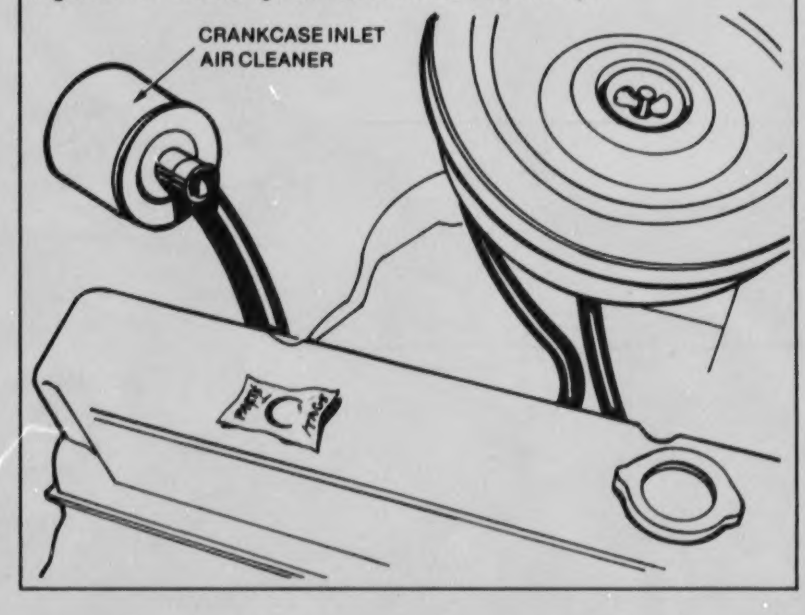


STEP 3 Reinstall the PCV valve. Then remove the crankcase inlet air cleaner, inlet hose, or oil filler cap.

STEP 4 Hold a parts tag or similar piece of stiff paper loosely at the opening in the rocker cover or at the end of the inlet hose (see figure 33-11).

- The paper should be pulled in against the opening with some force after

Figure 33-11 Checking PCV Vacuum with a Piece of Paper



about a minute. (It takes about one minute for the engine crankcase pressure to lower.) This indicates that the PCV system is operating properly.

Tachometer Method

STEP 1 Operate the engine at normal curb idle and at normal engine operating temperatures.

STEP 2 Attach a tachometer to the engine. Then squeeze or clamp the PCV valve hose to stop all air flow.

- If the idle speed drops 60 RPM or more, the PCV system is functioning properly.
- If the idle speed drops less than 60 RPM, the system is probably clogged. You should install a new PCV valve, and then retest.

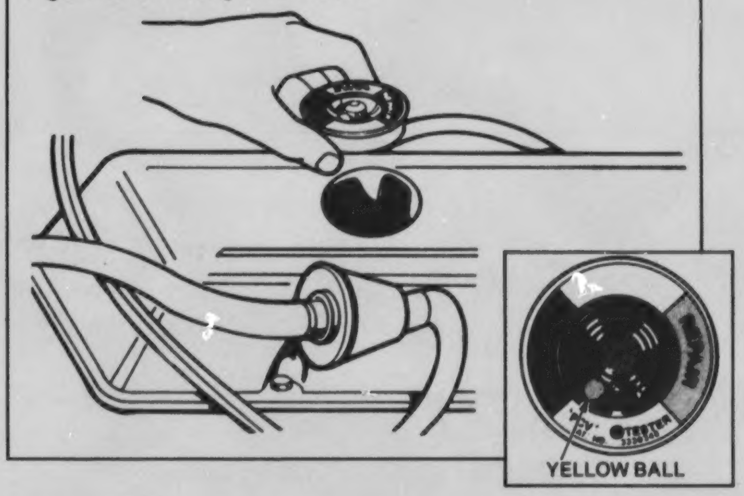
PCV Tester Method

Several types of testers are available that measure the passage of air circulating through the engine crankcase while the engine is operating. Always follow the instructions provided by the manufacturer of the tester.

STEP 1 Operate the engine at normal curb idle and at normal engine operating temperatures.

STEP 2 Remove the oil filler cap from the engine rocker cover. Place the PCV tester tightly over the oil fill hole or tube (see figure 33-12).

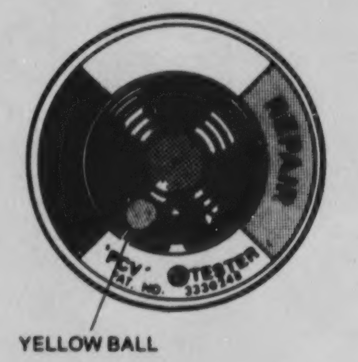
Figure 33-12 Using a PCV Tester



NOTE: During this test, be sure all the vents and hoses to the air cleaner are closed off and sealed. The PCV system must be sealed and free from air leaks.

STEP 3 Note the position of the yellow ball in the PCV tester.
- When the ball lies in the green (good) area, it indicates that the PCV system is functioning properly (see figure 33-13).
- When the ball lies in the red (repair) area, it indicates that the PCV system needs servicing.

Figure 33-13 PCV Tester Indicating That the PCV System Is Working Properly



Periodic testing and servicing of PCV systems are important. Clogged PCV valves or hoses cause:
- rough engine idle
- increased fuel consumption
- increased oil consumption (oil will be forced from the engine because of pressure buildup in the crankcase)
- oil contamination (sludge and acid will build up in the motor oil)

Turn to your Review Exercise Book and complete Exercise 1.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin any of the work activities until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

1. Look at the positive crankcase ventilation system on several vehicles and identify the main parts (pages 12-13).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

2. Visually inspect a positive crankcase ventilation system of a vehicle for defects. Write down the services needed (pages 13-14).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

3. Test a positive crankcase ventilation system of a vehicle for proper operation. Use the testing method recommended by the vehicle manufacturer (pages 14-17).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

When you have finished these activities, go on to the next section.

Servicing the PCV System

Most vehicle manufacturers recommend that you inspect, test, and service the PCV system every 12 months. It is also a good practice to service the PCV system at every tune-up service because of its affect on engine performance. Depending on the results of the PCV parts inspection and PCV system testing, the following service procedures would apply.

Figure 33-14 PCV Hoses and PCV Filters

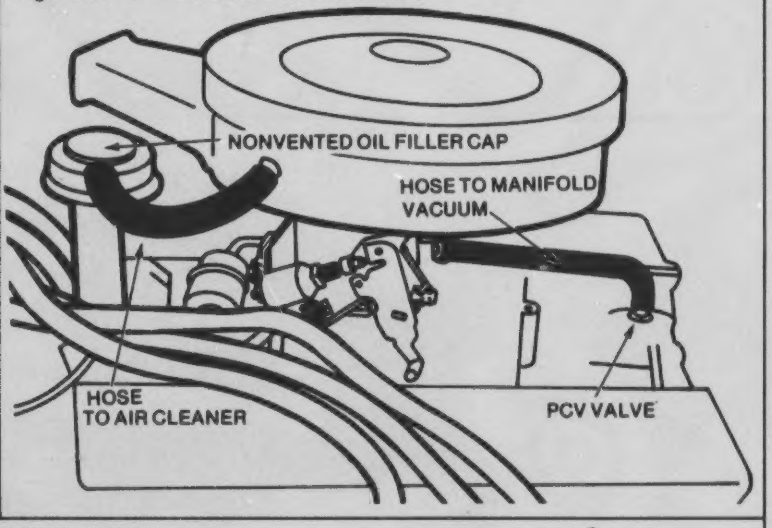
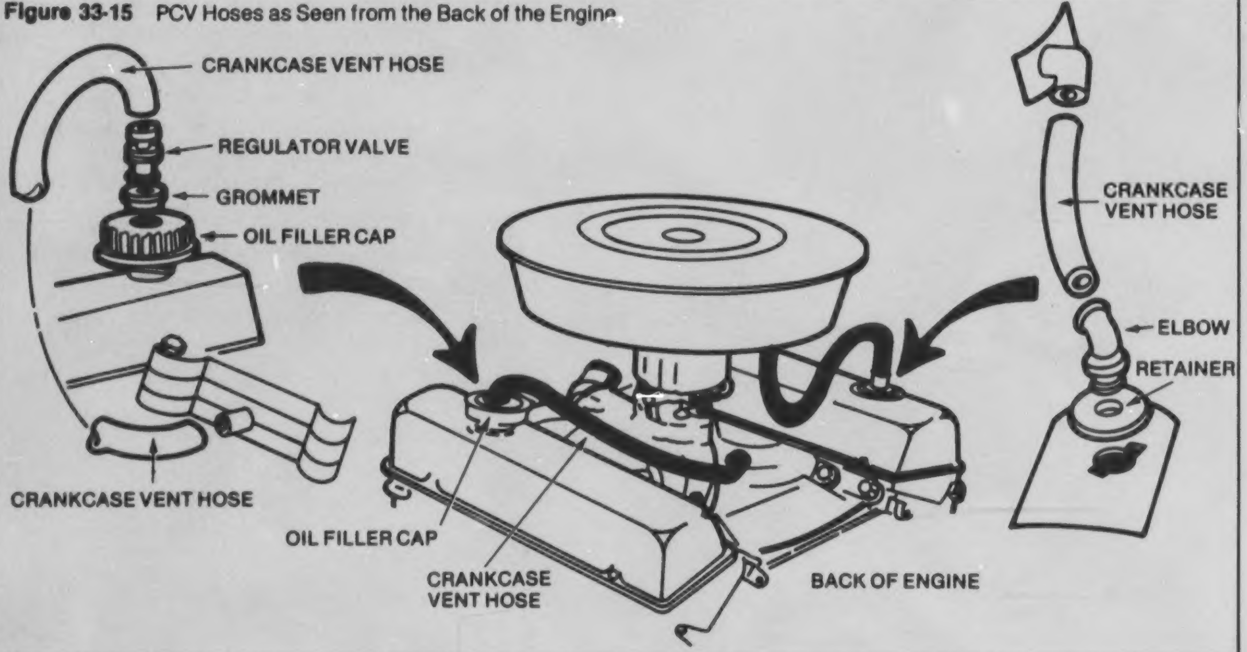

NONVENTED OIL FILLER CAP
HOSE TO MANIFOLD VACUUM
HOSE TO AIR CLEANER
PCV VALVE

Figure 33-15 PCV Hoses as Seen from the Back of the Engine


CRANKCASE VENT HOSE
REGULATOR VALVE
GROMMET
OIL FILLER CAP
CRANKCASE VENT HOSE
OIL FILLER CAP
CRANKCASE VENT HOSE
BACK OF ENGINE
CRANKCASE VENT HOSE
ELBOW
RETAINER

PCV hoses. PCV hoses should be replaced whenever they are cracked, kinked, or collapsed. Examples of PCV hose arrangements are shown in figures 33-14 and 33-15. To remove and clean the hoses, follow these steps:

STEP 1 Loosen the hose clamps (if present) at each end of the PCV hose that is to be cleaned.

STEP 2 Disconnect each end of the hose from its fitting and remove the hose from the vehicle.

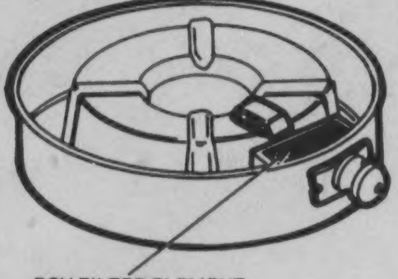
STEP 3 Clean the hose with the correct cleaner solvent. One manufacturer specifies the use of combustion chamber conditioner or a similar solvent.

NOTE: Hoses should not remain in the cleaning solvent for more than 1/2 hour.

STEP 4 Blow the PCV hose dry with compressed air. Then reinstall the hose on the engine.

PCV filter. See figure 33-16. For servicing procedures, refer to Performance Objective 23 in Unit 5.

Figure 33-16 Location of PCV Filter Element



Carburetor inlet passages. Some PCV valve hoses are attached to a fitting on the carburetor. If the PCV hose needs cleaning, check the carburetor inlet passage for clogging also. If the inlet passage is clogged, clean it by following these steps:

STEP 1 Remove the carburetor from the engine. If you need to review the procedures for carburetor removal and installation, refer to Performance Objective 30.

STEP 2 Select a drill that is smaller than the passage opening. Turn the drill by hand to remove the solid particles in the inlet passage. Then blow the passage clean.

NOTE: It is not necessary to disassemble the carburetor in order to clean this PCV carburetor passageway.

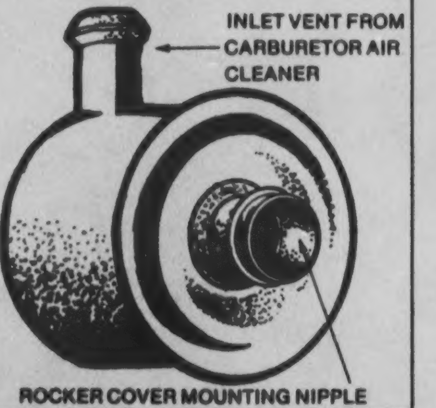
Crankcase inlet filter. It is recommended that you clean the crankcase inlet filter once every 12 months. Always follow the vehicle manufacturer's instructions when you do this procedure.

To clean the crankcase inlet filter, follow these steps:

STEP 1 Disconnect all hoses attached to the filter, and remove the filter from the vehicle (see figure 33-17).

STEP 2 Wash the filter thoroughly in cleaning solvent.

Figure 33-17 Crankcase Inlet Filter


INLET VENT FROM CARBURETOR AIR CLEANER
ROCKER COVER MOUNTING NIPPLE

STEP 3 Lubricate the filter by turning it upside down and filling it with SAE-30 engine oil.

STEP 4 Position the crankcase inlet filter so that excess oil can drain from the inlet vent.

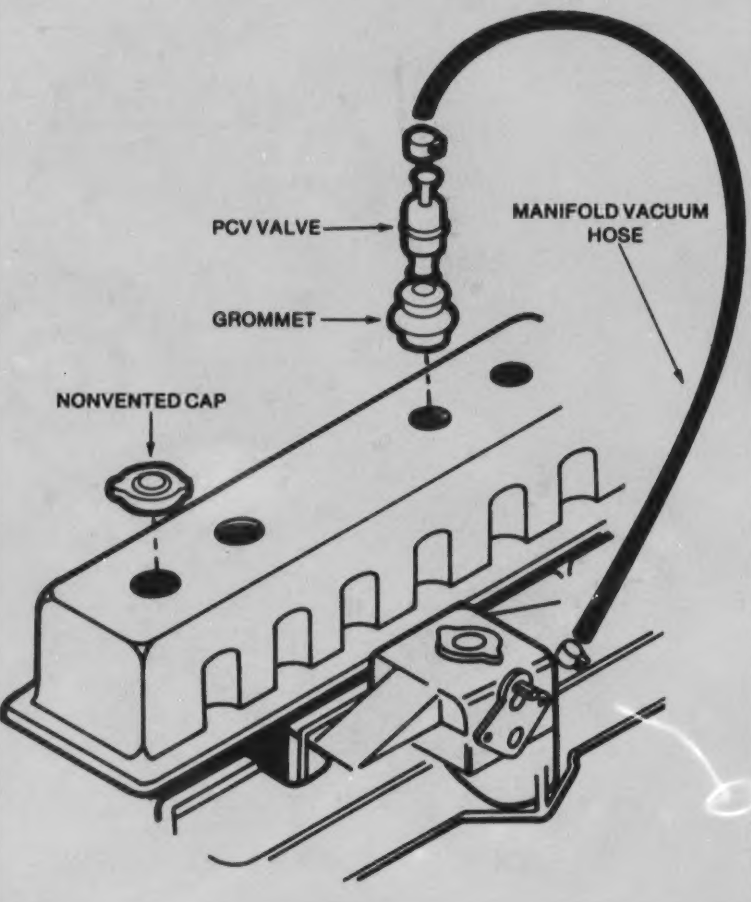
STEP 5 After the filter has thoroughly drained, reinstall it on the engine rocker cover and attach the connecting hoses.

PCV valves. Most vehicle manufacturers recommend that the PCV valve be replaced if it is not operating properly. In many instances, cleaning a PCV valve is not recommended.

To replace the PCV valve:

STEP 1 Remove the PCV valve from the engine rocker cover by working it up and out of its rubber grommet mounting (see figure 33-18).

Figure 33-18 PCV Valve Removed from Engine



2-

STEP 2 Loosen the PCV valve hose or the manifold vacuum hose clamp (if present) at the PCV valve end. Remove the valve from the hose. Note the position of the valve in the hose (see figure 33-18).

STEP 3 Look up the correct part number of the PCV valve in the parts catalogue for the vehicle year, make, and model being serviced. It is extremely important that you install the correct valve for the vehicle.

CAUTION: Do not try to match the PCV valve visually, because many of them look alike. Choose a replacement only by part number.

STEP 4 Insert the PCV valve into the PCV hose. Be sure the new PCV valve is positioned correctly, so that the crankcase vapors will move through the valve and into the carburetor or intake manifold.

CAUTION: Reverse installation of the PCV valve can cause an explosion if the engine backfires.

STEP 5 Tighten the hose clamp (if present) and install the PCV valve into its mounting grommet on the engine rocker cover. Be sure to replace the rubber grommet if it is cracked or deteriorated.

STEP 6 Retest the PCV system to ensure proper operation.

Turn to your Review Exercise Book and complete Exercise 2.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to the work activity. Do not begin the work activity until you have your instructor's approval. If you're not sure that you can do the work activity, ask your instructor for help.

4. Remove and install a positive crankcase ventilation valve (pages 21-22).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

5. Remove, clean, and install the crankcase inlet filter, if needed (pages 20-21).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

When you have finished these activities, ask your instructor to return your pretest on Performance Objective 33. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 34

PERFORM OPERATIONAL INSPECTION OF FUEL EVAPORATIVE EMISSION CONTROL SYSTEMS

INTRODUCTION

In this performance objective, you'll learn how to inspect and service vehicle fuel evaporative emission control systems. The functions of these systems are to control fuel vapors and keep them from escaping into the atmosphere from fuel tanks and carburetors.

After you have finished all the activities for Performance Objective 34, your instructor will use a checklist like the one below to evaluate your work.

PERFORMANCE CHECKLIST—P.O. 34

The instructor will provide either a live vehicle or a shop vehicle for this objective. Perform an operational inspection of the evaporative emission control system and correct any problems you find. All of the performances below must be accomplished.

Student Performances	**Instructor Ratings**		
	Acceptable	Not Acceptable	Omit
1. Raises the vehicle as necessary.			
2. Inspects all hoses and return lines for defects, and replaces as necessary.			
3. Inspects the vent control valve, if so equipped, and replaces as necessary.			
4. Lowers the vehicle as necessary.			
5. Inspects the pressure-vacuum filler cap, and replaces as necessary.			
6. Inspects the charcoal canister filter element, and replaces as necessary.			
7. Uses proper tools and equipment.			
8. Follows all appropriate safety precautions.			
9. Time.			

SAMPLE

Personal and Service Safety Practices

Safety Requirements for Hydraulic Equipment

Hydraulic floor jacks and jack stands.

- Place the jack securely under the vehicle frame. The frame provides one of the best jacking points.
- Slowly raise the vehicle with the jack. Be sure the vehicle is supported on the jack.
- Always support the vehicle with a jack stand that is in a secure position under the vehicle. This provides added safety in case the hydraulic floor jack should be lowered accidentally or fail while supporting the vehicle.
- Store the jack handle. Do not leave it on the floor. Someone could trip over it and get injured.

Hydraulic lift equipment.

- Check the rated capacity of the lift.
- Never put more weight on the lift than its rated capacity. This could damage the lift or cause the lift to fail.
- Never rock the vehicle in any direction while it is on the lift. The vehicle may fall off.
- Always be sure the vehicle is on the lift securely before raising it. This will prevent the vehicle from falling off after it is raised.

Safety when Servicing Fuel Evaporative Systems

- Never light a match, spark, cigarette, or any other flame while servicing fuel evaporative control systems. The flame could ignite the fuel vapors and cause an explosion or fire.
- Always plug vapor lines when servicing charcoal canisters or three-way control valves. This prevents fuel vapors from escaping.
- Always use fender covers when you work under the hood. This prevents scratching the finish on the fenders with tools and equipment.

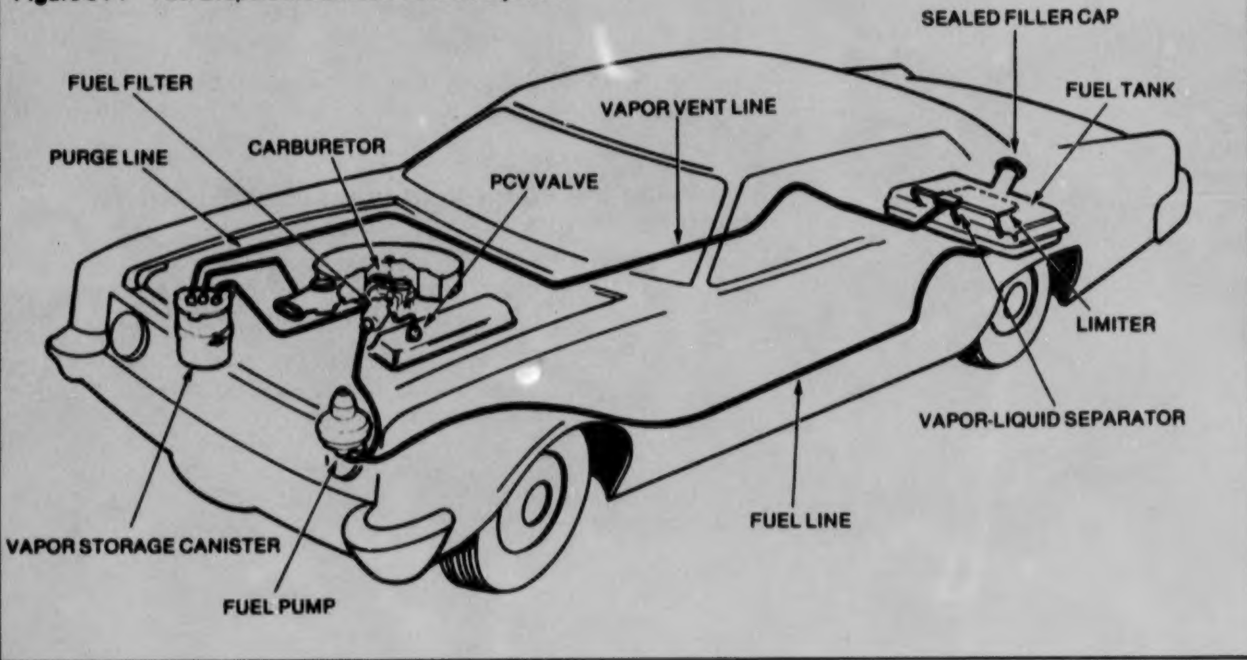
Safety in Work Clothing and Grooming

Eyes. Always wear eye protection when working under a vehicle. Dirt and other matter can get in your eyes.

Inspecting the Fuel Evaporative Emission Control System

To prevent gasoline vapors in vehicle fuel tanks and carburetors from escaping into the atmosphere, all vehicles built since 1971 have been equipped with fuel evaporative emission control systems. Fuel vapors from the fuel tank and the carburetor are stored in these systems when the vehicle is not operating. In some vehicles, these vapors are directed to and stored in a charcoal canister located in the engine compartment. In other vehicles, vapors are stored in the engine crankcase. When the engine starts, the stored-up vapors in either the canister or the engine crankcase are purged into the carburetor and intake manifold where they are burned in the normal combustion process.

Figure 34-1 Fuel Evaporative Emission Control System


SEALED FILLER CAP
FUEL FILTER
FUEL TANK
VAPOR VENT LINE
PURGE LINE
CARBURETOR
PCV VALVE
LIMITER
VAPOR-LIQUID SEPARATOR
FUEL LINE
VAPOR STORAGE CANISTER
FUEL PUMP

Inspecting and servicing the fuel evaporative emission systems involve the following main parts (see figure 34-1):

- fuel tank
- vapor vent lines and hoses
- vapor-liquid separator
- three-way control valve
- pressure-vacuum filler cap
- fuel vapor storage (charcoal canister)

Most U.S. vehicle manufacturers use evaporative emission control systems that are very similar in design. However, you'll need to know what to inspect and how to service each manufacturer's system by vehicle make. For a vehicle of a particular year, make, and model, always refer to your technical service manual.

Inspecting the Fuel Tank

STEP 1 Raise the vehicle on a hydraulic lift.

CAUTION: Be sure the vehicle is supported properly on the lift.

STEP 2 Inspect the fuel tank for leaks and looseness in its mountings.

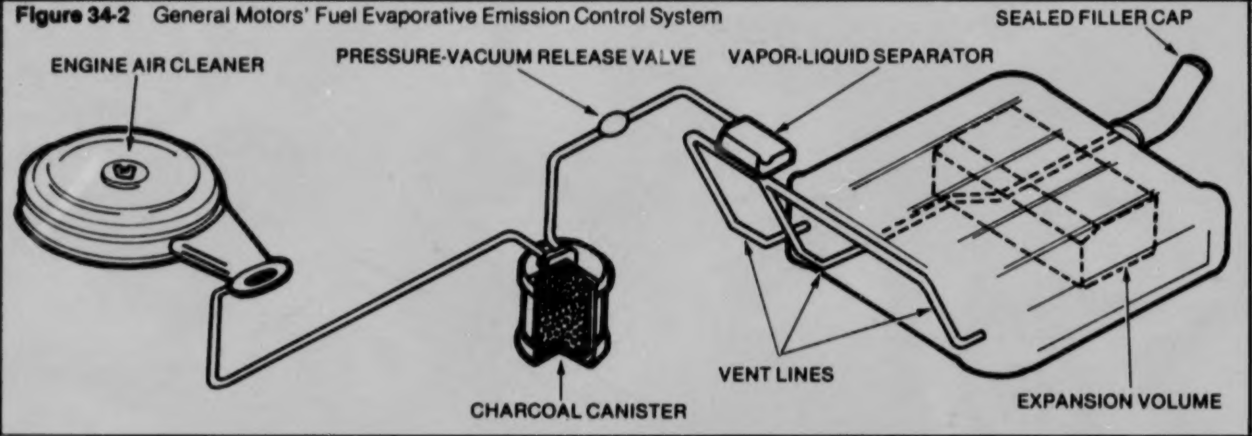
NOTE: If the fuel tank is leaking or loose in its mountings, correct these defects before going on to other inspections.

Inspecting the Vapor Vent Lines, Hoses, and Vapor-Liquid Separators

STEP 3 Inspect all vapor vent lines and hoses for loose connections, kinks, or areas that are broken, frayed, or worn.

STEP 4 Inspect the vapor separator for loose vapor line connections and loose separator mountings.

Figure 34-2 General Motors' Fuel Evaporative Emission Control System

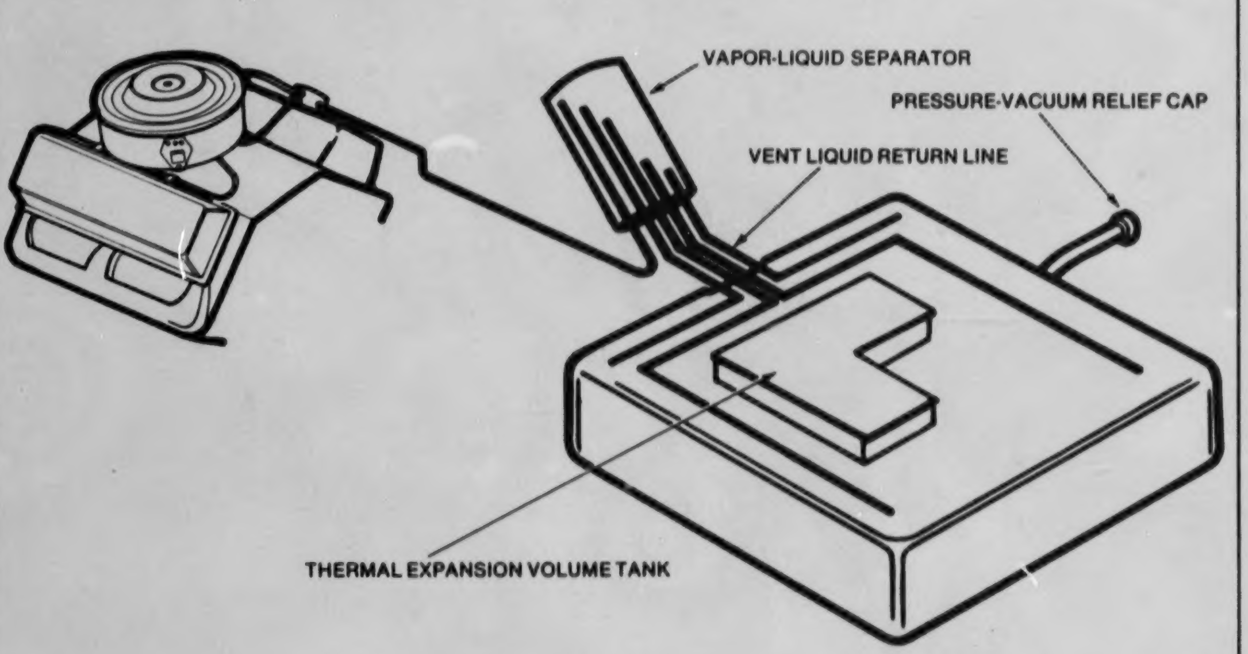

SEALED FILLER CAP
ENGINE AIR CLEANER
PRESSURE-VACUUM RELEASE VALVE
VAPOR-LIQUID SEPARATOR
VENT LINES
CHARCOAL CANISTER
EXPANSION VOLUME

Notice that on General Motors vehicles (see figure 34-2), the vapor lines from the fuel tank are directed into a vapor-liquid separator located above the tank. The purpose of the vapor-liquid separator is to prevent liquid fuel from being drawn into the engine through the closed vapor system whenever the vehicle is tilted. The separator allows vapors to travel to the canister, but returns liquid fuel to the tank.

The vapor-liquid separator is connected to the charcoal canister in the engine compartment by a single vapor line.

A pressure-vacuum relief valve, located in the vapor line, regulates pressure buildup in the fuel tank. Pressure must exist before the valve will let vapor move out of the tank and into the charcoal canister. The valve also lets air into the system at a specific vacuum. A defective pressure-vacuum relief valve could cause a fuel tank to collapse or become deformed. A defective valve could also draw liquid fuel into the charcoal canister.

Figure 34-3 1970-71 American Motors' and Chrysler Fuel Evaporative Emission Control System



Notice that on 1970-71 models of American Motors, Chrysler, and some Ford vehicles (see figure 34-3), vapors from the fuel tank are directed into the engine crankcase, where they are stored. A charcoal canister is not used on these systems. When the engine starts, the vapors are directed into the engine intake manifold by way of the PCV system.

Notice, also, that a pressure-vacuum relief filler cap is used on the fuel tank filler pipe. This special cap takes the place of a pressure-vacuum relief valve in the vapor vent line to the engine. However, some Chrysler vehicles use an ***overfill limiting valve*** in addition to a pressure-vacuum filler cap. An ***overfill limiting valve*** serves the same function as a pressure-vacuum relief valve.

Although the vapor-liquid separator shown in figure 34-3 differs from the General Motors' design, the purpose of the vapor-liquid separator remains the same.

Figure 34-4 Ford's Vapor-Liquid Separator on Top of Fuel Tank

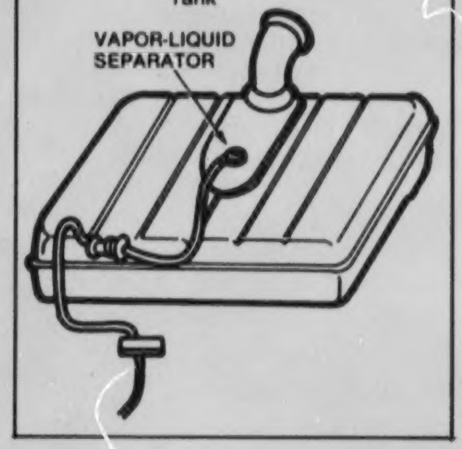
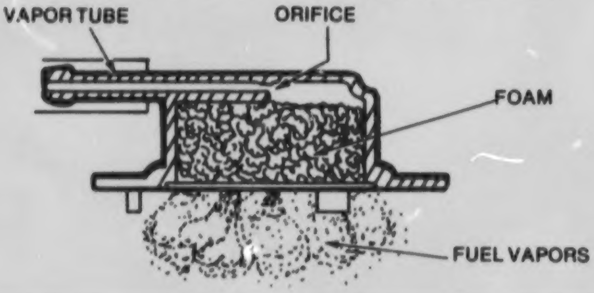
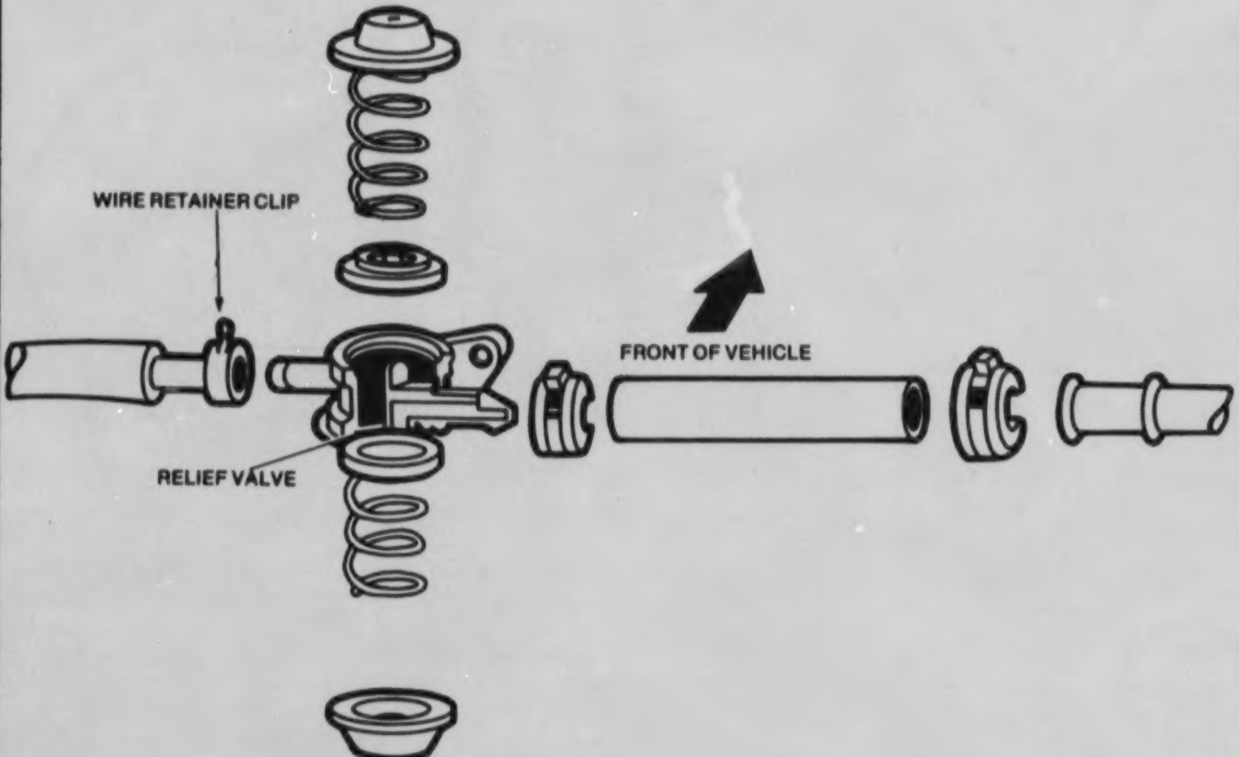

VAPOR-LIQUID SEPARATOR

Figure 34-5 Cutaway View of How the Vapor-Liquid Separator Works


VAPOR TUBE
ORIFICE
FOAM
FUEL VAPORS

On some Ford-built vehicles, the vapor-liquid separator is mounted in the center, on top of the fuel tank (see figure 34-4). Fuel vapors from the tank can pass through its foam-like material, but liquid fuel is trapped and returned to the fuel tank (see figure 34-5).

Figure 34-6 Ford's Three-Way Vent Control Valve


WIRE RETAINER CLIP
FRONT OF VEHICLE
RELIEF VALVE

Inspecting the Three-Way Control Valve

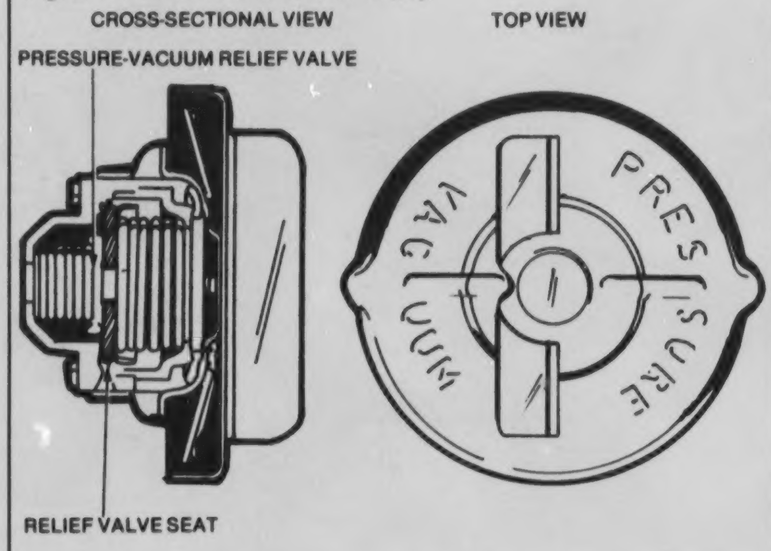
On some Ford models, a three-way vent control valve is located in the vapor vent line near the fuel tank (see figure 34-6). This valve serves the same purpose as the pressure-vacuum relief valve found in other evaporative emission control systems. The valve also allows venting to the outside atmosphere when pressure in the fuel tank builds too high. If a humming or buzzing sound is heard from the valve, it is defective and should be replaced. The vehicle manufacturer also recommends that the control valve be replaced every 12 months.

On these evaporative emission systems, only the fuel tank, vapor lines, and hoses can be repaired. Components that are damaged or that do not operate properly must be replaced.

Inspecting the Pressure-Vacuum Filler Cap

STEP 5 Lower the vehicle to the floor and inspect the pressure-vacuum filler cap.

Figure 34-7 Pressure-Vacuum Filler Cap



The fuel tank is equipped with a filler cap that lets air enter the tank at a specific vacuum and lets fuel vapors leave at a specific pressure. You'll find pressure-vacuum filler caps (see figure 34-7) on evaporative emission systems both with and without pressure-vacuum relief valves in the vent lines. Filler cap damage or a clogged, inoperative pressure-vacuum filler cap can result in damage to the vent lines and to the fuel tank, which will collapse and become deformed.

To check the filler cap:

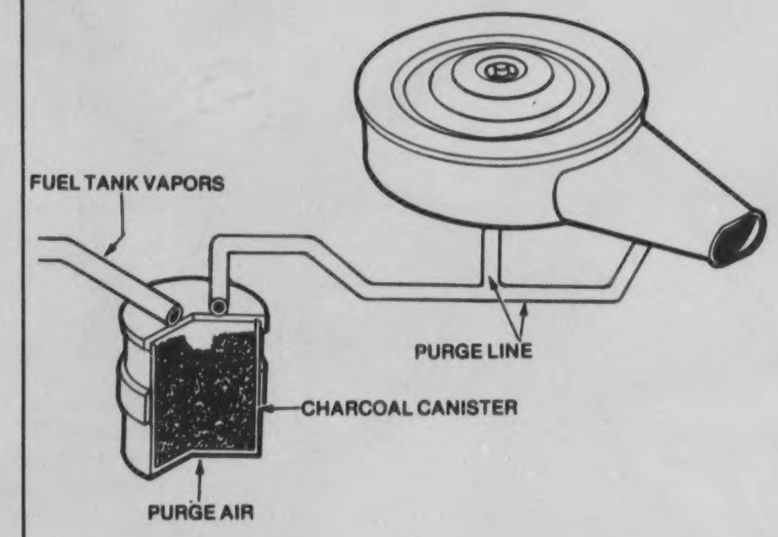
- Be sure the filler cap used is correct for the vehicle's year, make, and model.
- Remove the filler cap and, with your mouth against the opening in the housing, blow into the relief valve housing.
- A leakage of air with light blowing, or no release with hard blowing, indicates either a defective or an incorrect filler cap.

Inspecting the Fuel Vapor Storage (Charcoal Canister)

STEP 6 Inspect all evaporative emission vapor hoses in the engine compartment for loose connections, cracks, kinks, and worn areas.

- Charcoal canisters are located toward the front in the engine compartment, either on the left or right side, depending upon the vehicle's year, make, and model. The vapor hoses lead from the canister to the carburetor air cleaner (see figure 34-8).

Figure 34-8 Charcoal Canister in a Fuel Evaporative Emission Control System



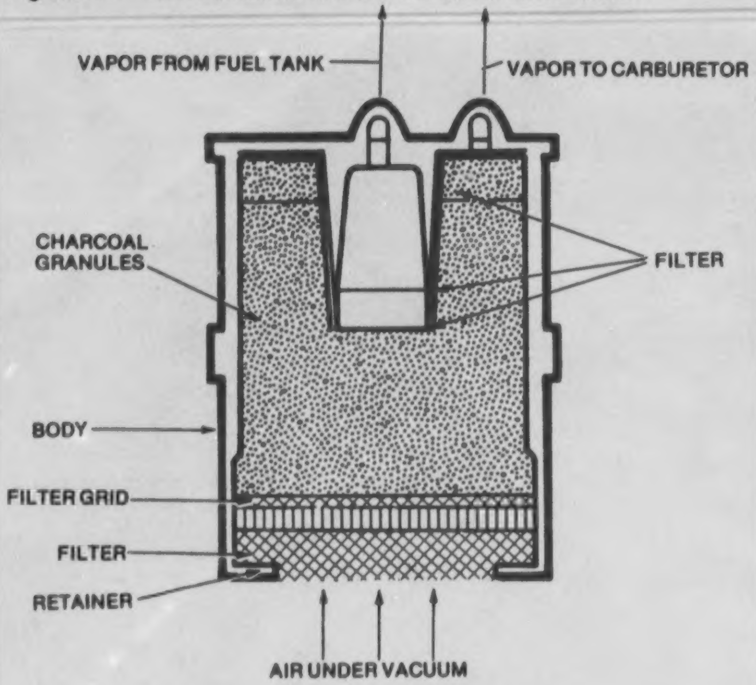
40

On some models, vapor hoses lead to the carburetor, intake manifolds, and PCV hoses. The routing of vapor hoses is determined by the vehicle manufacturer and the method used to purge the vapors from the canister to the engine once the engine starts.

You'll also find vapor hoses leading from the carburetor float bowl to the canister or to the crankcase. These hoses direct fuel vapors from the carburetor when the vehicle is parked.

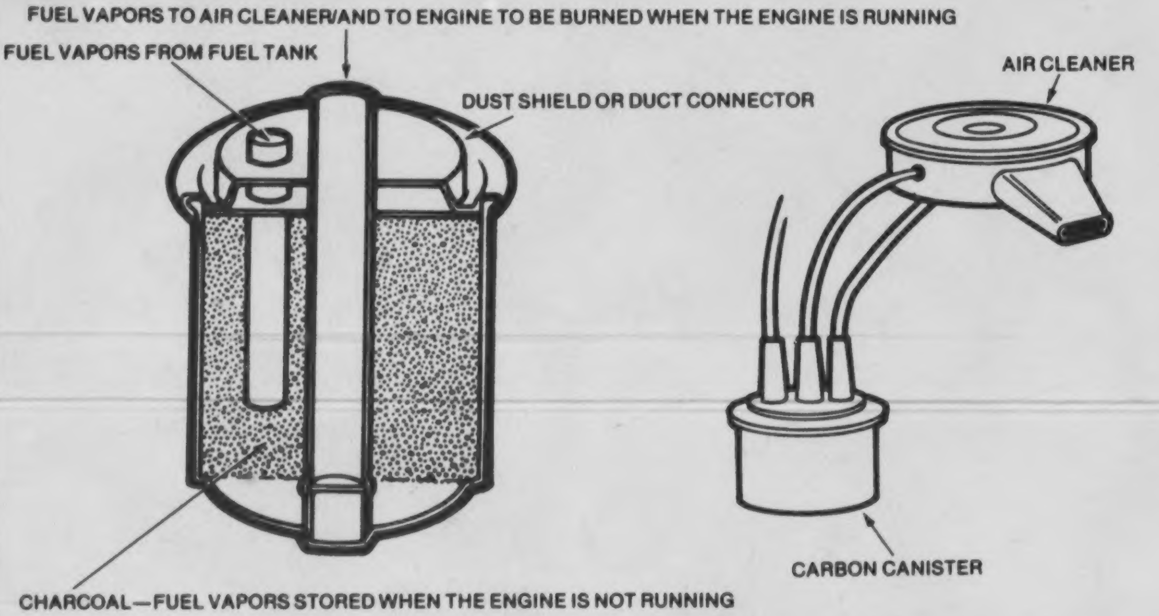
STEP 7 Periodic replacement of the charcoal canister filter element or of the entire canister is the only other service requirement.

Figure 34-9 Cross Section of How the Charcoal Canister Works



Inside the canister, the fuel vapors are stored on the surface of small particles of activated charcoal granules (see figure 34-9). When the engine is started, the vapors are pulled into the engine by engine vacuum. Engine vacuum pulls outside air in from the bottom of the canister and through the charcoal granules, drawing the fuel vapors along with it. The filter located in the bottom of the canister is an air filter. It needs to be replaced at recommended maintenance intervals.

Figure 34-10 Sealed Charcoal Canister


FUEL VAPORS TO AIR CLEANER/AND TO ENGINE TO BE BURNED WHEN THE ENGINE IS RUNNING
FUEL VAPORS FROM FUEL TANK
AIR CLEANER
DUST SHIELD OR DUCT CONNECTOR
CARBON CANISTER
CHARCOAL—FUEL VAPORS STORED WHEN THE ENGINE IS NOT RUNNING

There are two kinds of canisters. For one, servicing consists of replacing only the filter element at periodic intervals (see figure 34-9). The other is a sealed unit, and requires the replacement of the entire canister (see figure 34-10). Always refer to your technical service manual to find which kind you're servicing (by year, make, and model) and to find the recommended maintenance interval. For example:

- General Motors (1970-72): The filter element should be replaced every 12 months (more frequently if the vehicle is driven in dusty areas).
- General Motors (1973-75): The filter element should be replaced every 24,000 miles or evey 24 months (more frequently if the vehicle is driven in dusty areas).
- American Motors (1970-72): The filter element should be replaced every 12,000 miles.
- American Motors (1973-74): The filter element should be replaced every 15,000 miles.
- Chrysler (1972-75): The filter element should be replaced every 12,000 miles or every 12 months (more frequently if the vehicle is driven in dusty areas).

- Ford (all years): Check the service manual. On some models, the sealed canisters are replaced only if they are damaged or contaminated. On other models, the canisters should be replaced every 24,000 miles or 24 months.

Turn to your Review Exercise Book and complete Exercise 3.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin any of these work activities until you have your instructor's approval. If you're not sure you can do a work activity, ask your instructor for help.

1. Look at fuel evaporative emission control systems on several vehicles and identify the main parts of each system (pages 29-34).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

2. Draw a fuel evaporative emission control system and identify the main parts of the system (page 29).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

3. Inspect a fuel evaporative emission control system of a vehicle. Write down the services needed (pages 30-38).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

After you have finished these activities, go on to the next section.

Servicing the Fuel Evaporative Emission Control System

Vehicle fuel evaporative emission control systems should be checked and serviced according to their regular maintenance schedules. This means that at the time the canister filter needs replacing, the entire system (hoses, valves, tank filler caps, vapor-liquid separators) should also be checked.

Replacing Vapor Vent Hoses

To replace a vapor hose, disconnect each end of the hose from its fitting and remove the hose from the vehicle. Be sure to notice the way it is routed to each fitting. When installing, avoid making sharp bends and kinks in the hose as you route it to each fitting.

NOTE: Vapor hoses are fuel resistant, and are made from a special rubberlike material. Only hoses marked *EVAP* should be used for replacement. Ordinary fuel hoses should not be used because they deteriorate and clog the system.

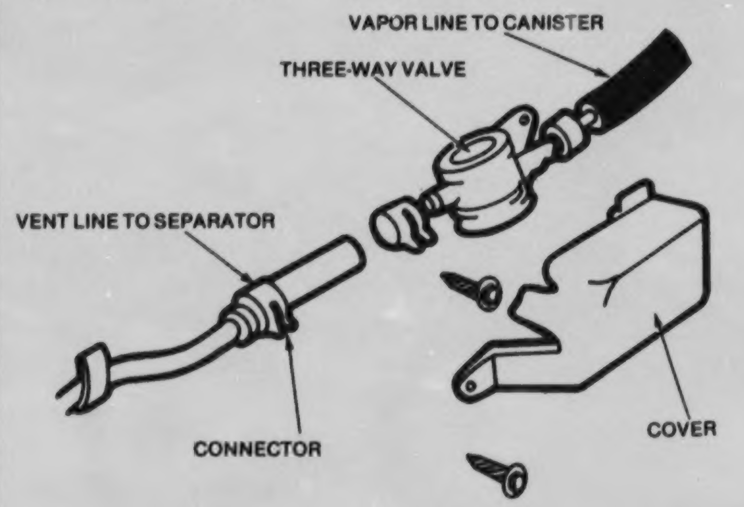
CAUTION: Never use a torch, or light cigarettes in the area of the fuel evaporative system. An open flame near these hoses may cause a fire and an explosion.

Replacing the Three-Way Control Valve

Some Ford vehicles have three-way control valves mounted on the frame side rail near the left rear wheel.

To replace the valve (see figure 34-11):

Figure 34-11 Replacing the Three-Way Control Valve



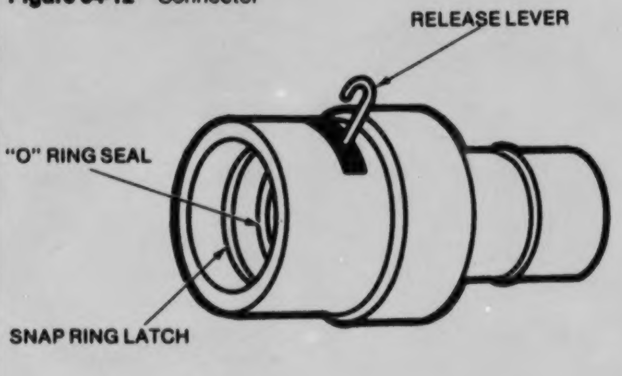
STEP 1 Raise the vehicle using a hydraulic lift.

CAUTION: Be sure the vehicle is supported properly on the lift.

STEP 2 Remove the protective cover from the valve body.

STEP 3 Remove the vapor line that goes to the canister. Then disconnect the connector from the vent line leading to the vapor-liquid separator.

Figure 34-12 Connector



You must depress the retaining wire clip (release lever) on the connector to the hose leading to the vapor-liquid separator before you can remove the connector (see figure 34-12).

STEP 4 Remove the three-way valve mounting bolt, and then remove the valve.

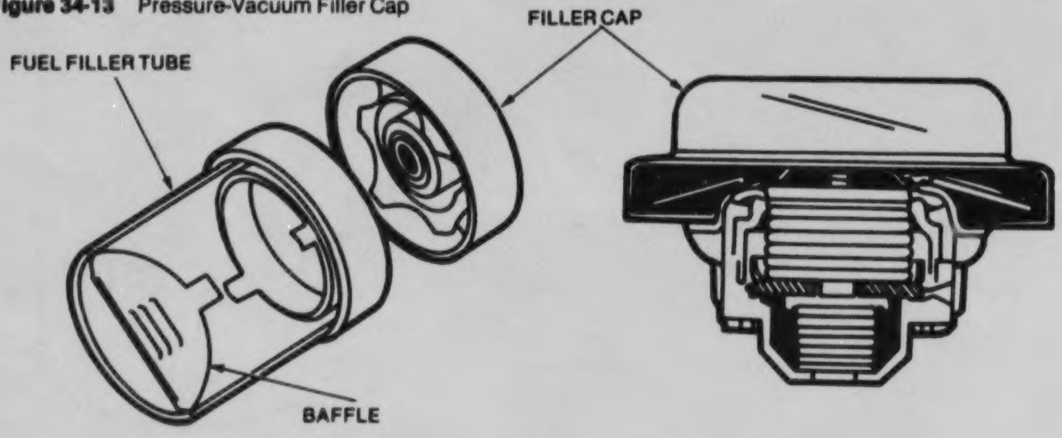
STEP 5 To install the three-way valve, reverse the procedures you followed for removal.

STEP 6 Lower the vehicle to the floor.

Replacing the Pressure-Vacuum Filler Cap

A pressure-vacuum filler cap that is inoperative or damaged should be replaced. Be sure to use the correct type of filler cap (see figure 34-13).

Figure 34-13 Pressure-Vacuum Filler Cap



CAUTION: Do not use a filler cap from a non-emission fuel tank on an emission fuel tank. Emission systems function properly only when they are sealed. Since non-emission filler caps are vented, using one will make an emission system inoperative.

On the other hand, if a nonvented filler cap is installed on a non-emission tank, the result will be a serious deformation or total collapse of the fuel tank.

Replacing the Canister Filter Element

Replacing the charcoal canister filter element is the most frequent service procedure performed on a vehicle's fuel evaporative emission control system. The filter element should be replaced at the maintenance interval recommended by the vehicle manufacturer.

In general, replace the canister filter element in the following way:

STEP 1 Disconnect the vapor hose(s) from the top of the canister.

NOTE: After you disconnect a vapor hose, be sure to plug it to prevent the escape of dangerous fuel vapors.

STEP 2 Loosen the mounting bracket clamp bolt (see figure 34-14) and slide the canister up out of the bracket. On some models, you'll have to remove the mounting bracket.

Figure 34-14 Charcoal Canister with Vapor Hoses Disconnected

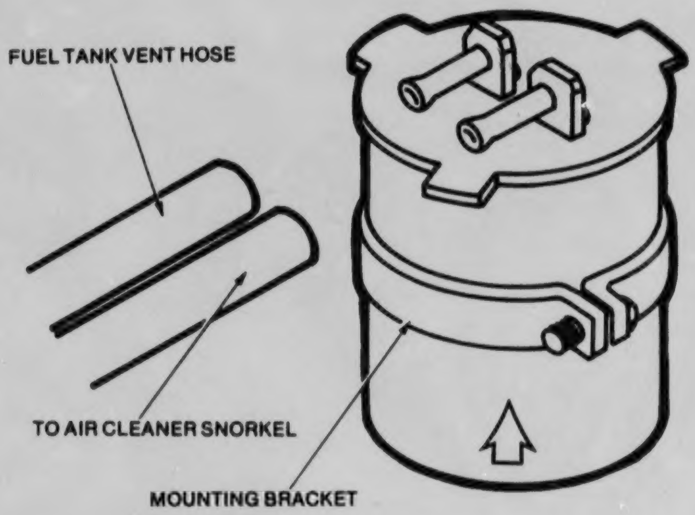


Figure 34-15 Removing the Canister Filter Element

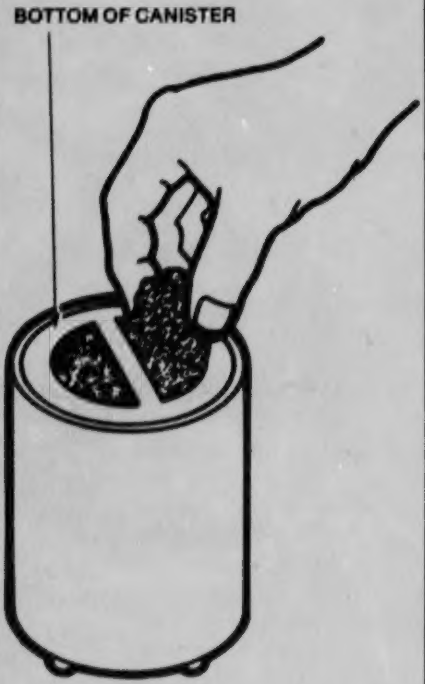
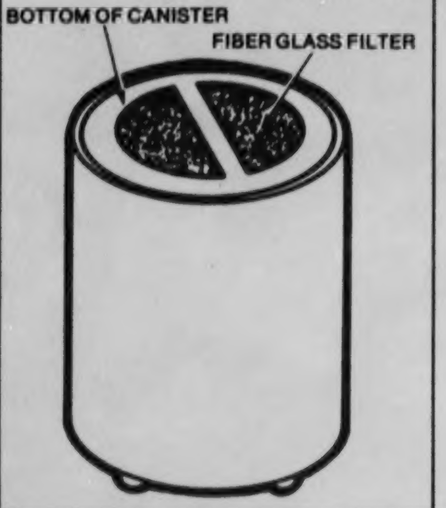


Figure 34-16 New Canister Filter Element Properly Installed



STEP 3 Turn the canister upside down and remove the cover from the bottom of the canister. (Remember, the bottom of the canister is now on top.) Pull the cover down to disengage the holding clips.

STEP 4 Remove the filter by squeezing it out from under the retainer bar. Discard the filter element (see figure 34-15).

NOTE: If you find raw fuel in the canister, replace the pressure-vacuum relief valve or the vacuum pressure filler cap, whichever is defective. If both valves are defective, replace both.

STEP 5 Install the new filter element by squeezing it under the retainer bar. Be sure to position it evenly around the entire bottom of the canister with the edges tucked under the canister lip (see figure 34-16).

STEP 6 Snap the bottom cover in place. Reinstall the canister in the mounting bracket. Unplug and reconnect the vapor hoses.

Turn to your Review Exercise Book and complete Exercise 4.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin the work activity until you have your instructor's approval. If you're not sure you can do a work activity, ask your instructor for help.

4. Remove and install a charcoal canister filter element (pages 42-43).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

5. Remove and install a three-way control valve on a Ford vehicle, if one is available (pages 40-41).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

When you have finished these work activities, ask your instructor to return your pretest on Performance Objective 34. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

INTRODUCTION TO EXHAUST EMISSION CONTROL SYSTEMS

In this section of the Student Guide, you'll read about vehicle emission control systems that directly affect engine operation and the engine exhaust pollutants. You'll also read about ways to inspect, test, and service each of the systems. Inspection of all emission systems has become a necessary part of the total tune-up service. When these systems do not operate properly, engines cannot meet the exhaust emission standards of the federal government or the specifications of the vehicle manufacturer.

Five major exhaust emission control systems have been used at one time or another on newer vehicles. They are:

- Thermostatic Air Cleaner (TAC) systems
- Air Injector Reactor (AIR) systems
- Exhaust Gas Recirculation (EGR) systems
- Transmission Controlled Spark (TCS) systems
- Electronic Spark Control (ESC) systems

Each of these emission control systems will be discussed in the order in which they are listed above.

Then you'll learn how to use the Hydrocarbon-Carbon Monoxide (HC-CO) exhaust emission tester and how to interpret the tester readings.

Finally, you'll be required to perform a complete tune-up service on a vehicle as though you are actually on the job. You'll follow a tune-up service checklist as you do the work, because tune-up service involves nearly all the work activities you have performed.

Personal and Service Safety Practices

Safety when Working around an Operating Engine

Vehicle finish. Always use fender covers when you work under the hood to prevent scratching the finish with tools and equipment.

Personal safety. Do not reach into the engine compartment without looking. Your fingers could get caught in and cut by the moving parts. Always operate a vehicle engine in well-ventilated areas. If the vehicle is inside a building, be sure the shop exhaust removal system is turned on and can expel the harmful carbon monoxide fumes from the working area. If ventilation is not provided, these fumes could kill you.

Safety when Making Electrical Tests

Procedures. Always follow the procedures described by the manufacturer of the electrical equipment. This ensures proper care and use of the equipment as well as correct calibration of the equipment. In this way, you not only avoid damaging electrical test instruments, but you also ensure that you receive valid test readings.

Electrical tests. Never do any electrical tests while standing on a wet floor surface, or when engine parts are wet. A painful shock may result.

Storing equipment. Always store the HC-CO tester sampling hose and probe tip in a safe place after you do the tests to prevent the parts from being cut, kinked, or damaged by vehicles running over them.

Safety in Work Clothing and Grooming

Hair. Keep hair away from moving parts of an operating engine. If your hair is longer than conventional length (reaches over your shirt collar), wear a hair net or keep it under a hat.

Jewelry. Avoid wearing any metal (rings, buckles, wristwatch bands, neck pendants, and so on) that, on contact with electrical parts, cause severe burns.

Clothing. Avoid wearing loose clothing or anything that can hang down and get caught in the moving parts of an operating engine. Injury can result. Loose clothing can also catch on engine parts and tear.

PERFORMANCE OBJECTIVE 35

INSPECT, TEST, AND SERVICE THERMOSTATIC AIR CLEANER (TAC) SYSTEMS

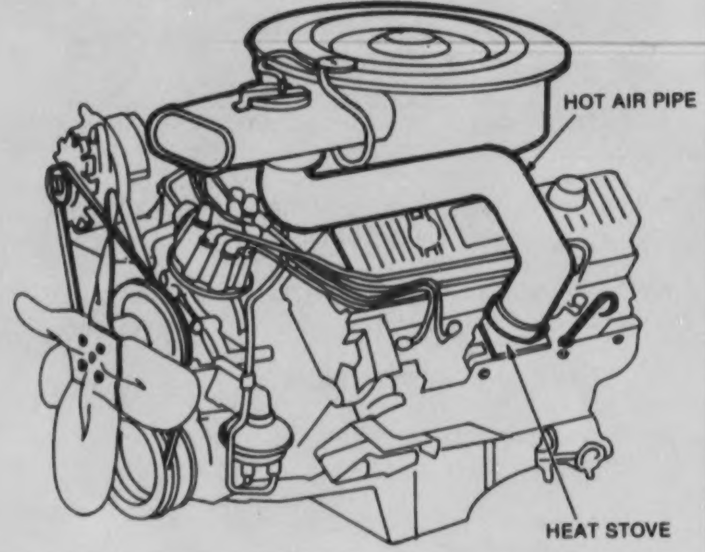
INTRODUCTION

Since 1970, all American-made vehicles have been equipped with thermostatically controlled carburetor air cleaners.

The purpose of this exhaust emission control unit is to supply warm air from around the exhaust manifold (heat stove) to the carburetor during engine warm-up. This warm air helps to vaporize the air-fuel mixture when the engine is cold (see figure 35-1).

The system keeps the air that enters the carburetor at approximately 100°F. By maintaining this air temperature, the carburetor can be calibrated for a much leaner air-fuel mixture that, in turn, reduces emissions, improves engine warm-up periods, and reduces carburetor icing.

Figure 35-1 Thermostatically Controlled Carburetor Air Cleaner Mounted on Engine



PERFORMANCE CHECKLIST—P.O. 35
FORD TAC SYSTEM

Performance Objective 35, *Inspect, Test, and Service Thermostatic Air Cleaner (TAC) Systems,* has three checklists. Three checklists are necessary because there are three major types of TAC systems, each different from the other. After you finish the work activities for each of these systems, your instructor will use a checklist like the one below to evaluate your work. The other two checklists are for testing and servicing (1) Chrylser's TAC system and (2) General Motor's TAC system.

Student Performances	**Instructor Ratings**		
	Acceptable	Not Acceptable	Omit
1. Inspects the thermostatic air cleaner system of a Ford vehicle.			
2. Tests the operation of the thermostatic air cleaner system of a Ford vehicle.			
3. Tests the operation of the thermostatic bulb on the TAC system of a Ford vehicle.			
4. Tests the operation of a vacuum override motor on the TAC system of a Ford vehicle.			
5. Tests the operation of a bi-metal switch on the TAC system of a Ford vehicle.			
6. Tests the operation of an auxiliary air inlet valve on the TAC system of a Ford vehicle.			
7. Corrects any problems found.			
8. If available, adjusts the thermostatic bulb setting on a TAC system of a Ford vehicle.			
9. Uses thermometer, hot plate, and vacuum-pressure gauge.			
10. Follows all appropriate safety precautions.			
11. Time.			

SAMPLE

Operation of the GM and Chrysler TAC

On General Motors and Chrysler systems, the emission control device consists of five main parts (see figure 35-2):

- temperature sensor or thermostat
- vacuum motor
- control damper assembly
- hot air pipe or duct
- vacuum hoses

Figure 35-2 Components of the TAC

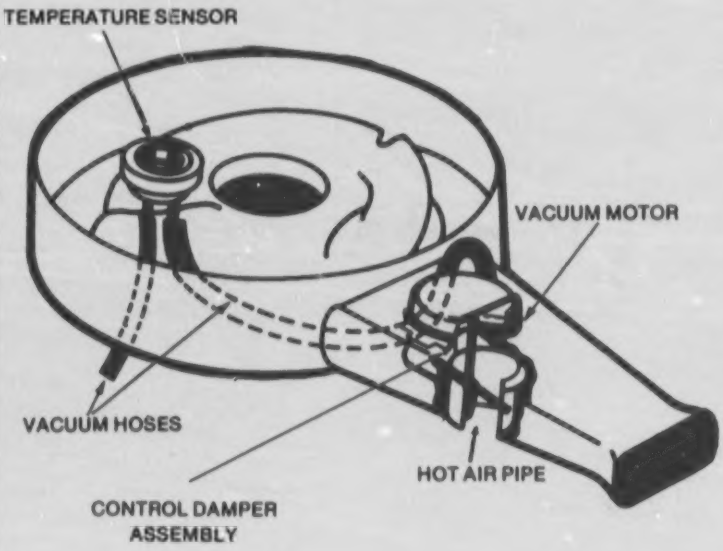
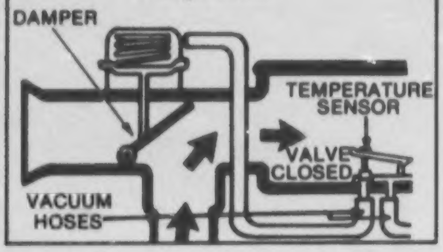

TEMPERATURE SENSOR
VACUUM MOTOR
VACUUM HOSES
HOT AIR PIPE
CONTROL DAMPER ASSEMBLY

Figure 35-3 Damper Open to Heat Stove: Engine Cold


DAMPER
TEMPERATURE SENSOR
VALVE CLOSED
VACUUM HOSES

The temperature sensor inside the air cleaner housing uses vacuum assist to control the opening and closing of the damper assembly. The damper is open to the heat stove until the air temperature in the air cleaner housing reaches about 100°F. (see figure 35-3).

Figure 35-4 Damper Partially Closed to Heat Stove: Engine Warming Up

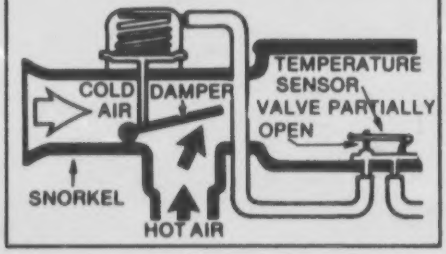
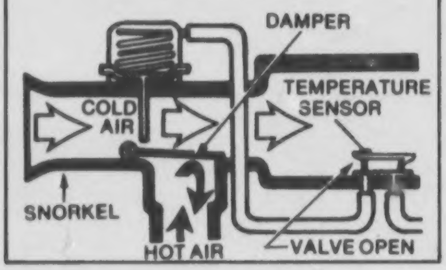


Figure 35-5 Damper Completely Closed to Heat Stove: Engine Hot



As the air temperature rises in the air cleaner housing, the damper partially closes to the hot air. This allows cooler air from under the hood to be drawn through the snorkel and mixed with the heated air (see figure 35-4).

When the air temperature reaches the desired level (approximately 100°F.), the damper closes off the heat stove, and only outside air enters through the snorkel (see figure 35-5).

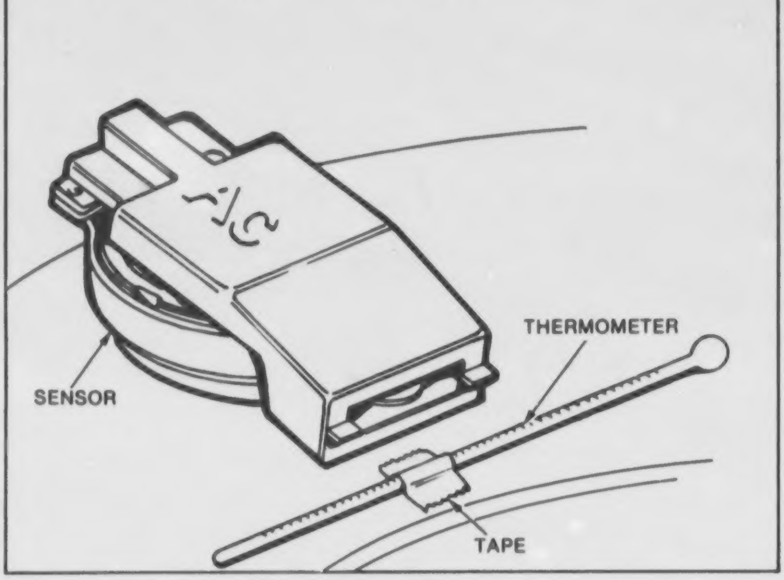
Inspecting and Testing the GM TAC

During every tune-up service (every 12,000 miles or every 12 months), the thermostatic air cleaner vacuum hoses and the connector from the heat stove should be checked to make sure that their condition and connections are good. Using a hand mirror, visually inspect the damper valve to see if it is open to outside air (engine warm) or closed to outside air (engine cold). Make this inspection while the engine is operating.

If the vehicle owner complains that the engine stumbles, stalls, and accelerates poorly when the engine is cold, or that the engine pings when it is hot, you'll need to check the operation of the entire TAC device more accurately. To do this, follow these steps:

STEP 1 On General Motors vehicles, remove the air cleaner cover and place a thermometer next to the temperature sensor. Attach it securely with masking tape (see figure 35-6).

Figure 35-6 Using a Thermometer to Check TAC Device



STEP 2 Install a tee in the vacuum line at the vacuum motor on the air cleaner snorkel and connect a vacuum gauge to the line.

STEP 3 Look up the temperature sensor specifications for the year and make of the vehicle in your technical service manual.

- The specifications will look something like those shown in Table 35-1.

Table 35-1 Temperature Sensor Specifications

APPLICATION	OPENING TEMP.	CLOSING TEMP.
Cadillac (1970-74) all V-8	85°F.	105°F.
Chevrolet (1968-74) all engines	85°F.	128°F.

- The specification table shows that on all 1970-1974 V-8 Cadillacs, the damper valve should start to ***open*** to allow outside air in at 85°F. and should ***close*** to stop the hot air from the heat stove at 105°F.
- The table also shows that on all 1968-1974 Chevrolet engines, the damper valve ***opens*** at 85°F. and ***closes*** at 128°F.

STEP 4 Let the air cleaner cool to at least 7 degrees below the ***closing*** temperature.

- Noting the Chevrolet information in the table, you can see that the temperature shown on the thermometer should cool down to at least 121°F. if the engine is warm.

STEP 5 With the engine turned off, visually check the damper. The control damper should be ***open*** to the outside air. If the damper is closed to the outside air, the damper assembly is defective and needs to be replaced.

STEP 6 Install the cover on the air cleaner without installing the wing nut, and start the engine. With the engine at idle, and while the temperature is below the closing temperature of the sensor, the damper should close against outside air.

STEP 7 Watch the damper in the snorkel and, as it starts to move toward the open position (open to outside air), quickly remove the cover on the air cleaner. Read the thermometer and the vacuum gauge. Write down your test readings.

NOTE: When the damper is closed to the outside air, the vacuum should register from 5 to 9 inches of mercury (Hg).

STEP 8 Reinstall the air cleaner cover without installing the wing nut, and wait until the damper is fully open. Then write down the thermometer and vacuum readings.

GOOD When the damper is fully open, the vacuum should register 3 inches Hg or less and the temperature should match the closing temperature specifications of the sensor. For example, the temperature for the Chevrolet should be 128°F.

BAD If the vacuum gauge reading is correct, but the temperature is not within manufacturer's specifications, replace the sensor.

- If both the temperature and the vacuum readings are not within specifications, replace the vacuum motor.

Servicing the GM TAC

Replace the sensor in the carburetor air cleaner housing by removing the air cleaner housing from the vehicle.

STEP 1 Remove the filter element.

STEP 2 Turn the air cleaner housing over and remove the two retaining clips from the sensor vacuum hose connectors (see figure 35-7).

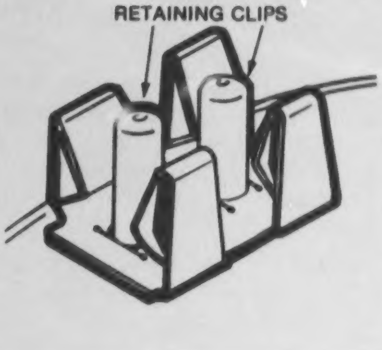
STEP 3 Remove the temperature sensor from inside the air cleaner housing.

STEP 4 Install a new sensor by following the removal steps in reverse order.

STEP 5 Install the vacuum hoses and the carburetor air cleaner housing on the engine, and retest its operation.

To replace the damper assembly, including the vacuum motor, it is necessary to remove the carburetor air cleaner housing from the vehicle.

Figure 35-7 Retaining Clips on the Sensor Vacuum Hose Connectors



58

STEP 1 Drill out the spot welds that hold the assembly in the snorkel. Remove the damper assembly.

STEP 2 Install the new damper assembly in the snorkel of the air cleaner and secure it with sheet metal screws.

Turn to your Review Exercise Book and complete Exercise 5.

WORK ACTIVITIES

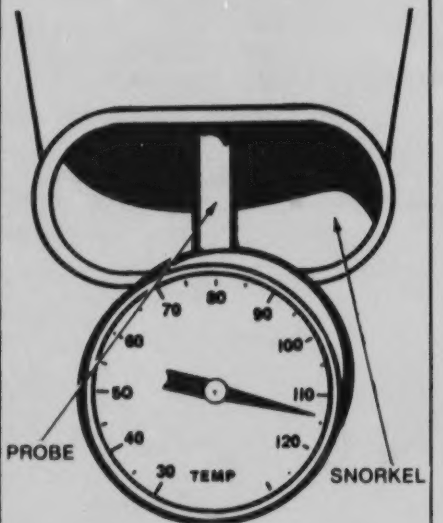
Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to the work activity. Do not begin the work activity until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

1. Inspect and test the operation of a GM thermostatic carburetor air cleaner. Write down your thermometer and vacuum readings and compare them with the vehicle manufacturer's specifications (pages 52-54).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

After you have finished this activity, go on to the next section.

Figure 35-8 Checking the Temperature of the Chrysler TAC



Inspecting and Testing the Chrysler-made TAC

STEP 1 Check to be sure that all vacuum hoses and the connector from the heat stove are in good condition and have good connections.

STEP 2 With the engine cold and the temperature in the engine compartment lower than 100°F., check that the heat control door (damper) in the snorkel is in the *up* or ***heat on*** position. Use a hand mirror to check the position of the damper through the snorkel.

STEP 3 With the engine running at normal operating temperature, check the temperature of the air as it enters the snorkel or at the sensor (see figure 35-8).

NOTE: When the air temperature reaches 105°F. or higher, the door should be in the *down* position.

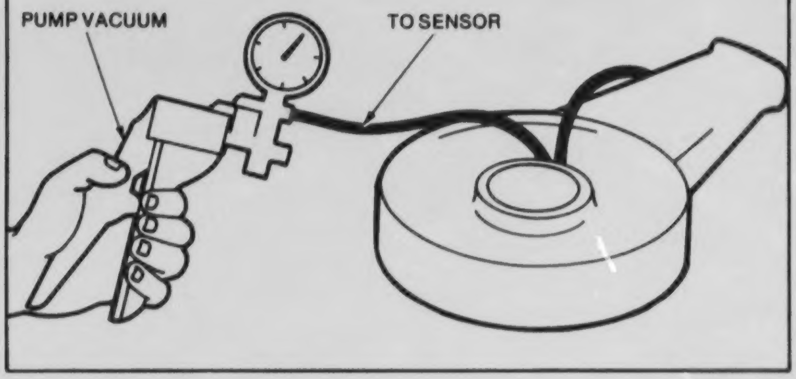
NOTE: If the test results are good, there is no need to test further. The thermostatic air cleaner is working properly.

- However, if the test results are not satisfactory, you'll need to test further to locate the trouble in either the sensor or the vacuum diaphragm.

STEP 4 Turn off the engine and remove the carburetor air cleaner from the engine and let the sensor cool to approximately 90°F.

STEP 5 Then attach a hand vacuum pump that has a gauge unit to the vacuum hose leading to the sensor in the air cleaner (see figure 35-9).

Figure 35-9 Checking the TAC Sensor

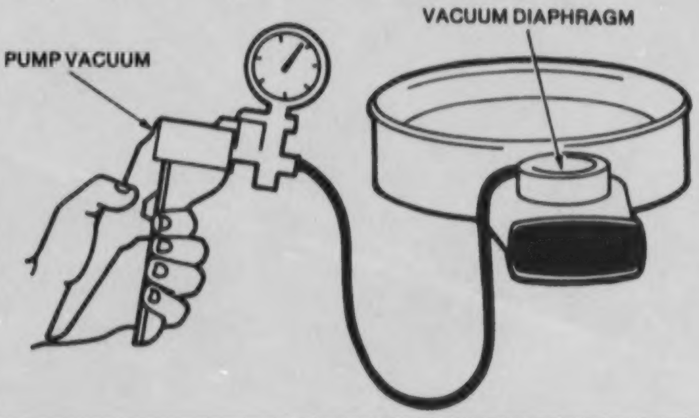


STEP 6 Apply 20 inches of Hg. The door or damper should be in the *up* or ***heat on*** position.

- If the damper does not rise to the ***heat on*** position, check the vacuum diaphragm to see if it is working.

STEP 7 To test the diaphragm, apply 20 inches of Hg to the vacuum diaphragm located on the snorkel of the carburetor air cleaner (see figure 35-10).

Figure 35-10 Checking the TAC Vacuum Diaphragm



- Clamp off the vacuum line and check for diaphragm leaks. The diaphragm should hold a vacuum of 20 inches Hg for five minutes.

STEP 8 Release the vacuum and build it back again slowly. Watch the operation of the door.

- The door should lift off the bottom of the snorkel when the vacuum is at least 5 inches Hg and be in full *up* position at no more than 9 inches Hg.
- If the vacuum diaphragm leaks or does not perform adequately, it should be replaced.
- If the vacuum diaphragm is okay, but the door does not shut at the proper temperature (105°F.), the sensor should be replaced.

Servicing the Chrysler-made TAC

Replace the sensor in the carburetor air cleaner housing by removing the air cleaner housing from the vehicle.

STEP 1 Remove the filter element.

STEP 2 Turn the air cleaner housing over and remove the two retaining clips from the sensor vacuum hose connections (see figure 35-11).

Figure 35-11 Removing the Retaining Clips from the Sensor Vacuum Hose Connections

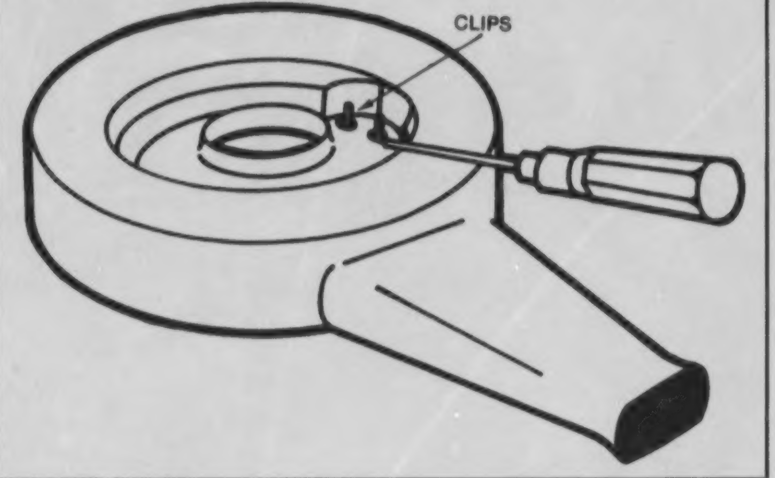
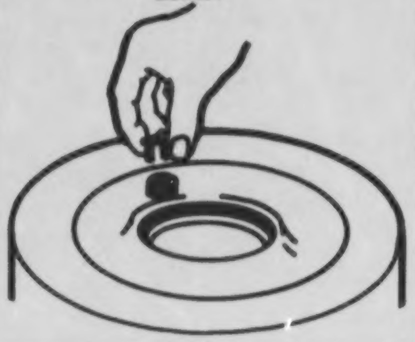


Figure 35-12 Removing the Sensor and Gasket



STEP 3 Remove the sensor and gasket (see figure 35-12).

STEP 4 To install a new sensor, place a new gasket on the air cleaner housing and install the new sensor.

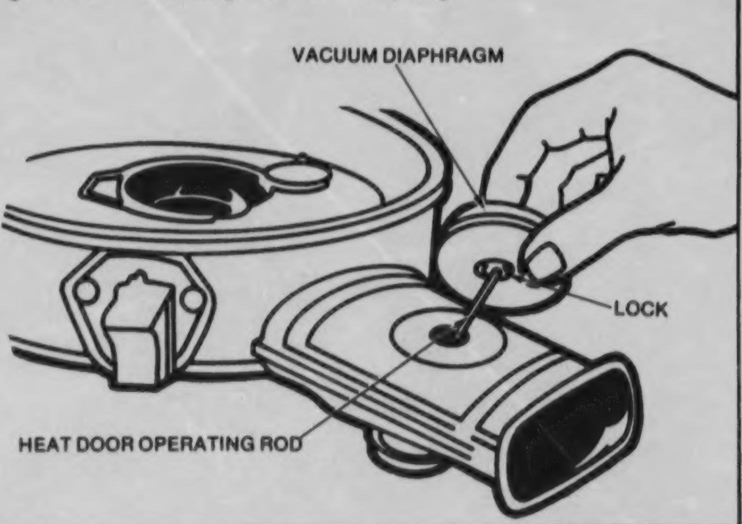
STEP 5 Support the sensor by its outside edges and install the two new retaining clips.

STEP 6 Install the vacuum hoses and the carburetor air cleaner on the engine. Retest its operation.

To replace the vacuum diaphragm, you need to remove the carburetor air cleaner from the vehicle.

STEP 1 Disconnect the vacuum hose from the diaphragm. Then tip the diaphragm slightly forward to disengage the lock. Rotate the diaphragm counterclockwise (see figure 35-13).

Figure 35-13 Replacing the Vacuum Diaphragm



STEP 2 When the diaphragm is free from the snorkel, slide the complete assembly to one side and disengage the operating rod from the heat control door. Remove the vacuum diaphragm from the snorkel.

STEP 3 With the diaphragm removed, check the door to see if it moves freely. If it does not, check the snorkel side walls for interference.

STEP 4 To install the vacuum diaphragm, first insert the diaphragm rod into the heat control door. Then position the diaphragm into the openings in the snorkel and turn it clockwise until the lock is engaged.

STEP 5 Apply a vacuum of 9 inches Hg to the diaphragm hose nipple. The door should operate freely.

CAUTION: Do not operate the heater door manually. You could knock the heater door and its rod out of alignment, restricting its operation.

STEP 6 Reinstall the carburetor air cleaner on the engine and test its operation.

Turn to your Review Exercise Book and complete Exercise 6.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin any of these work activities until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

2. Inspect and test the operation of a Chrysler-made thermostatic carburetor air cleaner. Write down your thermometer readings and compare them with the vehicle manufacturer's specifications (pages 57-58).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

3. Remove and install a thermal sensor and a vacuum diaphragm on a Chrysler-made thermostatic air cleaner (pages 59-60).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

After you have finished these activities, go on to the next section.

Operation of the Ford/AMC-made TAC

On Ford (1971-74) and American Motors thermostatic air cleaners, the emission control device consists of a (see figure 35-14):

- thermostat bulb
- thermostat rod
- valve plate
- exhaust manifold shroud tube
- vacuum hose
- vacuum override motor

Figure 35-14 Components of the Ford/AMC TAC

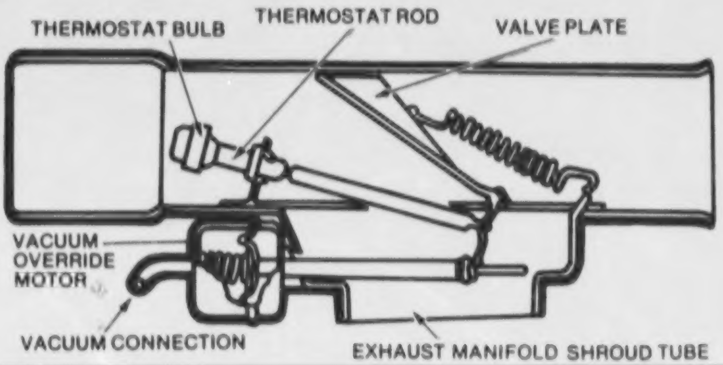


Figure 35-15 Valve Plate Open to Heat Stove: Engine Cold

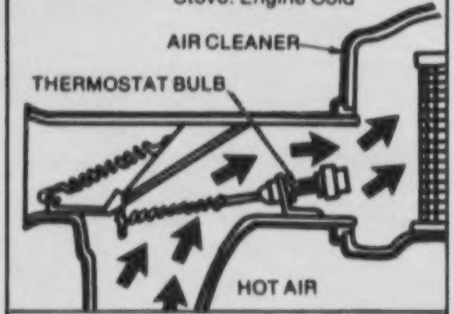
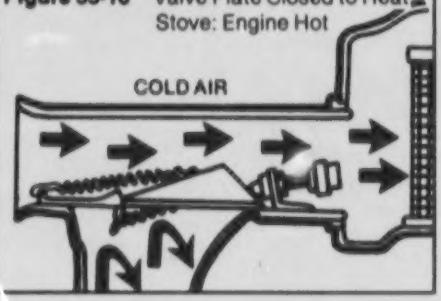


Figure 35-16 Valve Plate Closed to Heat Stove: Engine Hot



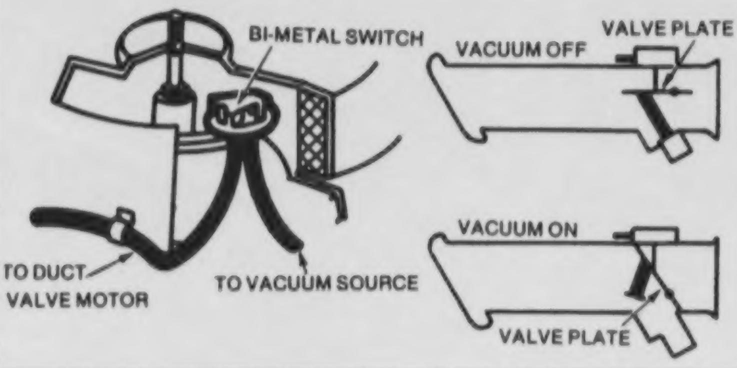
The temperature sensor in the Ford air cleaner is a thermostatic bulb housed inside the air cleaner snorkel. It operates the valve plate through a mechanical linkage. The override motor closes the valve plate against hot manifold air when acceleration takes place while the engine is still cold. It does this by overriding the thermostatic bulb and letting in the outside air that is needed during acceleration.

The thermostatic bulb inside the air cleaner snorkel controls the opening and closing of the valve plate by means of a mechanical linkage. The valve plate is *open* to the heat stove until the temperature of the air in the air cleaner housing reaches about 100°F. (see figure 35-15).

When the air temperature reaches the desired level (approximately 100°F.), the valve plate closes off the air from the heat stove and only outside air enters through the snorkel (see figure 35-16).

Some Ford thermostatic air cleaners manufactured between 1971 and 1974 use a vacuum-operated valve, controlled by a bi-metal switch. The switch acts as the temperature sensor and is located in the carburetor air cleaner (see figure 35-17).

Figure 35-17 Ford TAC Using a Vacuum-Operated Valve Controlled by a Bi-Metal Switch

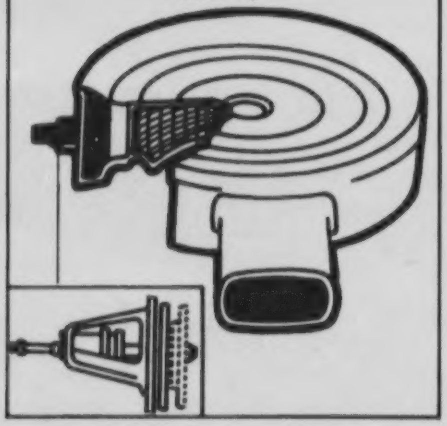


When the engine compartment temperature is lower than about 80°F., the switch is closed. This allows vacuum to pass through the switch and *close* the valve plate to air from the engine compartment.

When the temperature reaches about 80°F., the bi-metal switch opens and bleeds off the vacuum. Without the vacuum, the valve plate closes against the hot air coming from the manifold heat stove, forcing the carburetor to receive air from the engine compartment.

Some Ford thermostatic air cleaners also have an auxiliary air inlet valve located on the side of the carburetor air cleaner (see figure 35-18). Vacuum-operated, the purpose

Figure 35-18 Ford's Auxiliary Air Inlet Valve and Vacuum Motor Assembly



of the auxiliary air inlet valve is to provide additional carburetor air during acceleration and full-throttle operation.

The vacuum in the intake manifold decreases when the engine is accelerated. A decrease in engine vacuum opens the valve and allows more air to enter the carburetor.

Inspecting and Testing the Ford-AMC-made TAC

STEP 1 Make sure that all vacuum hoses and the connector from the heat stove are in good condition and have good connections.

STEP 2 When the engine is off and cold, and the temperature in the engine compartment lower than 100°F., check to see that the valve plate in the snorkel is ***open*** to engine compartment air. On thermostatic air cleaners that have a vacuum override motor, the valve plate should be about one-half open.

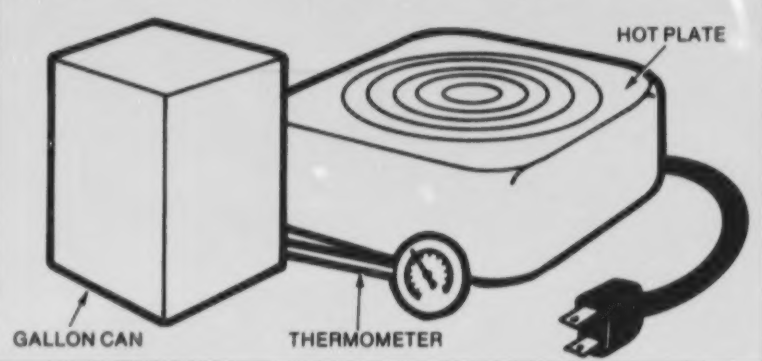
- Check the position of the valve plate by using a hand mirror to look through the snorkel.

STEP 3 If the valve plate is not in the proper position, start the engine and watch valve plate action.

- When the engine is cold and operating, the valve plate should be in the full ***heat on*** position and closed to the outside air. As the air in the engine compartment warms up, the valve plate should start to open to the outside air and to close off the hot air flow from the manifold heat stove.

STEP 4 If not, here are the tools necessary to test the thermostatic bulb in the snorkel of the air cleaner (see figure 35-19).

Figure 35-19 Tools Needed to Test the Thermostatic Bulb



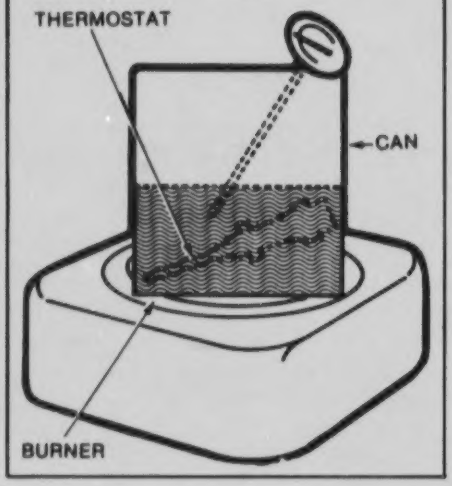


Figure 35-20 Testing the Snorkel

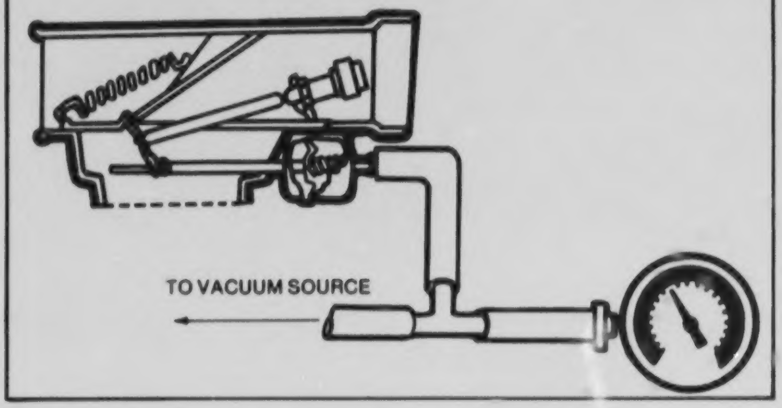
STEP 5 Remove the snorkel (including the air duct and valve plate assembly) from the air cleaner. Place it in a one-gallon can of cold water, and set the can on the hot plate (see figure 35-20).

- Place a thermometer in the water and watch the temperature while you heat the water slowly.
- At 100°F., the valve plate should be in the closed or ***heat on*** position.

STEP 6 Heat the water to 135°F. The valve should start to open as the temperature rises above 100°F.
When the water temperature reaches 135°F., the valve plate should be in the ***fully open*** or ***heat off*** position.
Refer to ***Servicing the Ford-AMC-made TAC,*** for the proper servicing procedures to follow when the test results are not satisfactory.

NOTE: Air cleaners that are equipped with vacuum override motors will need to be tested if the valve plate did not operate properly during the visual checks.

Figure 35-21 Vacuum Gauge Connected to Hose



STEP 7 If the valve remains in the half-open position when you test the TAC on the engine, remove the vacuum hose at the override motor and install a tee in the hose. Connect a vacuum gauge to the tee (see figure 35-21).

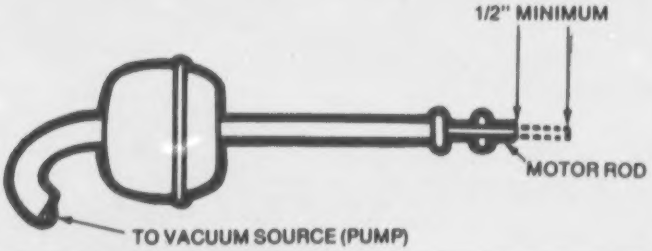
STEP 8 Start the engine and watch the vacuum gauge reading.

- If the vacuum is less than 15 inches of Hg, check for vacuum leaks either in the hoses and connections or at the override motor.

- If the amount of vacuum is sufficient, but the valve plate still did not operate and no binding exists in the movement of the valve, stop the engine and remove the vacuum override motor from the air cleaner.

STEP 9 Test the vacuum override motor. Connect it to a vacuum pump, apply vacuum, and watch the movement of the motor rod (see figure 35-22).

Figure 35-22 Testing the Vacuum Override Motor

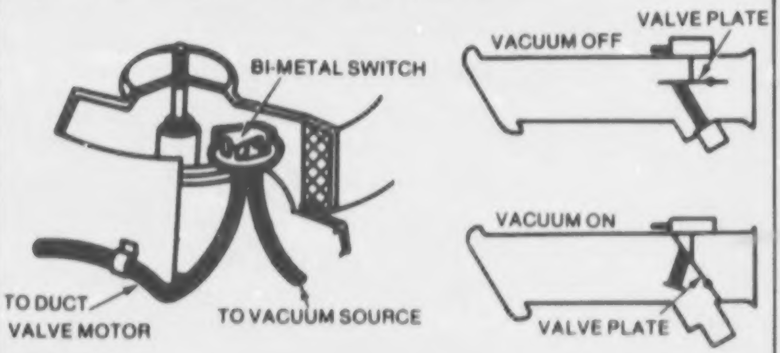

1/2" MINIMUM
MOTOR ROD
TO VACUUM SOURCE (PUMP)

GOOD If the motor rod moves a minimum of 1/2 inch, the motor is functioning correctly. Reinstall the motor and check for binding or misalignment.

BAD If the motor rod does not move 1/2 inch, the motor is defective and should be replaced.

STEP 10 On air cleaners in which the valve plate is operated by a bi-metal thermal switch, visually check the position of the valve plate (see figure 35-23).

Figure 35-23 Check the Position of the Valve Plate


BI-METAL SWITCH
TO DUCT VALVE MOTOR
TO VACUUM SOURCE
VALVE PLATE
VACUUM OFF
VACUUM ON
VALVE PLATE

- With the engine turned off, the valve plate should be open to engine compartment air.
- Start the engine and operate it at idle speed. The valve plate should close to engine compartment air unless the engine is at normal operating temperatures.

STEP 11 If the engine is cold and the valve plate does not close during idle, check for vacuum hoses that are disconnected from the vacuum motor and the bi-metal switch.

- Check the bi-metal switch to be sure that the bleed valve is closed.

STEP 12 Open and close the throttle rapidly. The valve plate should open when the throttle is opened.

- If the valve plate doesn't function properly, check for binding of the valve plate.

STEP 13 If the cause of the malfunction has not been detected, test the bi-metal switch (see figure 35-24).

- You can test the switch either by using heated air or by removing the switch from the air cleaner and placing it in heated water.
- At 80°F., the bi-metal strip should unseat the bleed valve. Only a slight movement of the bi-metal strip is necessary.
- If the bi-metal switch fails the test, it must be replaced.

STEP 14 On air cleaners that have an auxiliary air inlet valve, remove the cover of the carburetor air cleaner.

Figure 35-24 Bi-Metal Switch

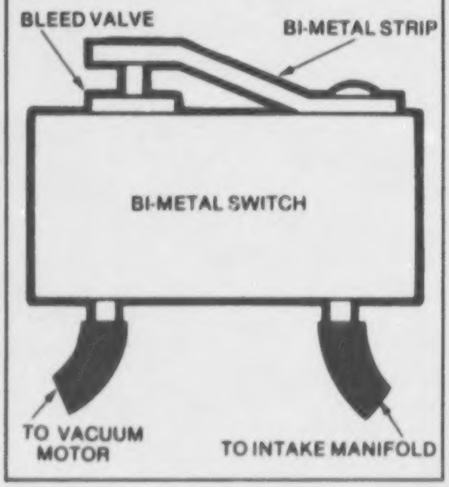
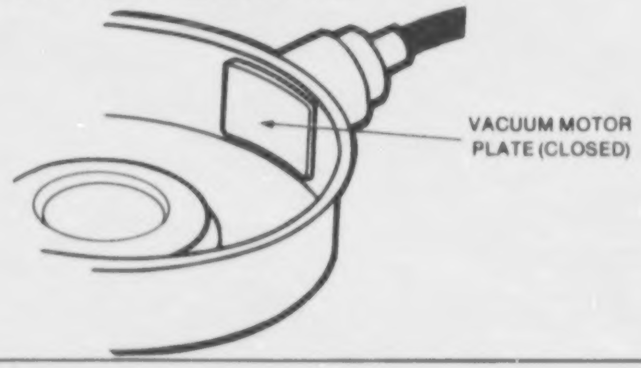


Figure 35-25 Vacuum Motor Plate Closed

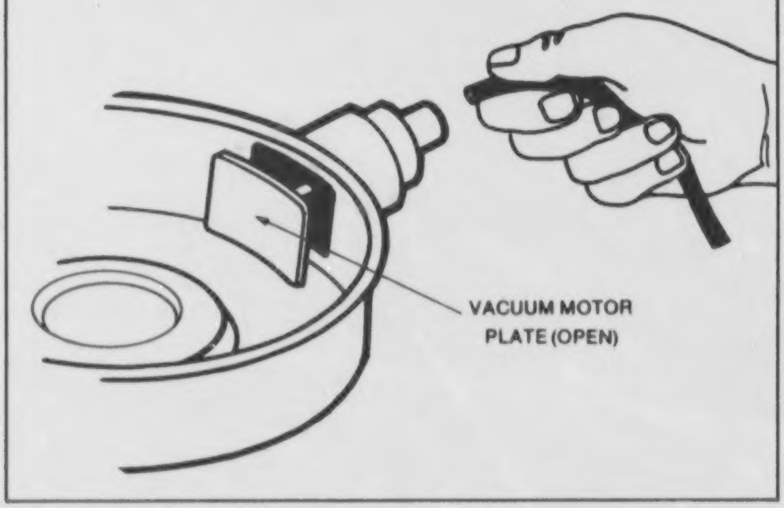


- Start the engine and look at the vacuum motor plate. It should be fully closed (see figure 35-25).

STEP 15 Disconnect the vacuum hose at the valve. The plate should move to a fully open position (see figure 35-26).

- If the vacuum plate does not fully open or fully close properly, check the vacuum hose and connections for leaks. If the vacuum hose is okay, replace the auxiliary air inlet valve.

Figure 35-26 Vacuum Motor Plate Open



Servicing the Ford/AMC-made TAC

Thermostatic bulb. The manufacturer's specifications indicate that the valve plate should be closed at 100°F. and should open at 135°F.

- If the thermostatic bulb test results do not meet the manufacturer's specifications, the bulb must be replaced.
- On 1968-70 Ford vehicles, the thermostatic valve can be adjusted to change the valve opening at the air temperature.

To adjust the thermostatic valve on these vehicles:

STEP 1 Loosen the jam nut and turn the thermostat *clockwise* to move the valve plate toward the *heat off* position (see figure 35-27).

- Turn the thermostat *counterclockwise* to move the valve plate toward the

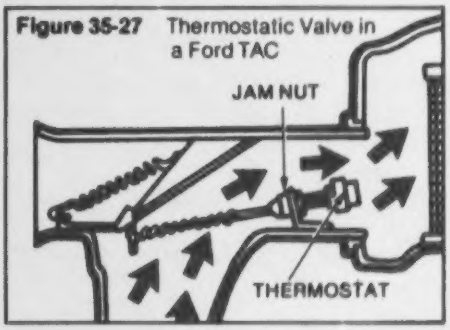


Figure 35-27 Thermostatic Valve in a Ford TAC

heat on position.

STEP 2 Retest the thermostatic bulb and valve opening to check the adjustments you've made.

Vacuum override motor. The manufacturer's specifications state that the vacuum motor rod should move at least 1/2 inch.

- If the vacuum override motor test results do not meet manufacturer's specifications, the vacuum override motor must be replaced.

Bi-metal switch. The manufacturer's specifications state that the bi-metal strip should unseat the bleed valve at 80°F.

- If the bi-metal switch test results do not meet manufacturer's specifications, the bi-metal switch must be replaced.

Auxiliary air inlet valve.

- If the auxiliary air inlet valve does not function properly, it must be replaced.
- The auxiliary air inlet valve should be fully closed with the engine idling, and fully opened when its vacuum hose is disconnected.

Turn to your Review Exercise Book and complete Exercise 7.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin any of these work activities until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

4. Inspect and test the operation of a Ford/AMC-made thermostatic air cleaner (pages 63-67).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

5. Inspect and test the operation of a vacuum override motor both on and off the vehicle (page 68).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

6. Inspect and test the operation of a bi-metal switch both on and off the vehicle (page 68).

CHECK YOUR WORK WITH YOUR INSTRUCTOR..

7. Inspect and test the operation of an auxiliary air inlet valve (page 68).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

When you have finished these work activities, ask your instructor to return your pretest on Performance Objective 35. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will tell you if you are ready to be checked off on the performance checklists or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklists, carefully tear the checklists out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 36

INSPECT, TEST, AND SERVICE AIR INJECTION SYSTEMS

INTRODUCTION

An air injection system is an emission control device that injects slightly compressed air into the engine's exhaust manifold and exhaust ports. It creates afterburning in the exhaust manifold, burning off any leftover and unburned exhaust gases. Air injection reduces the amount of exhaust emissions coming from the vehicle's exhaust by extending the combustion process in the exhaust manifold.

Figure 36-1 Air Injection System: External View

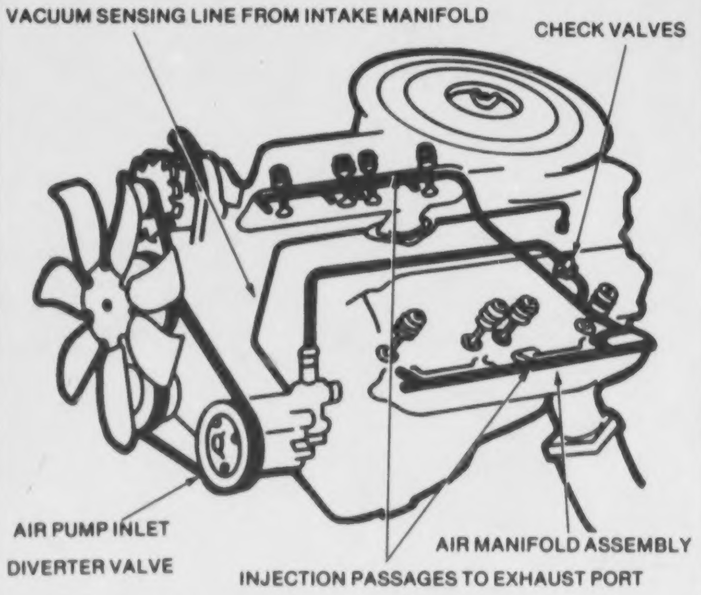
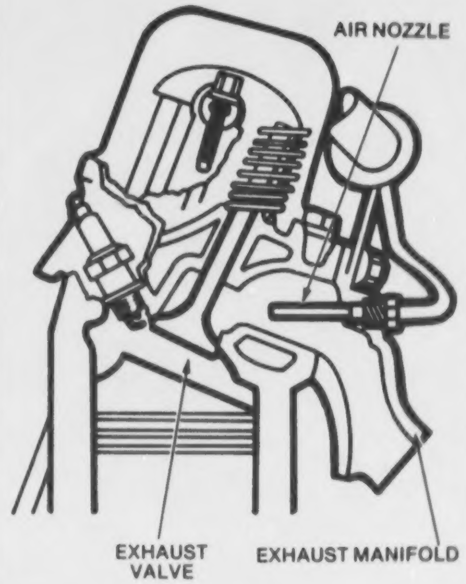

VACUUM SENSING LINE FROM INTAKE MANIFOLD
CHECK VALVES
AIR PUMP INLET
DIVERTER VALVE
AIR MANIFOLD ASSEMBLY
INJECTION PASSAGES TO EXHAUST PORT

Figure 36-2 Internal View of Air Injection


AIR NOZZLE
EXHAUST VALVE
EXHAUST MANIFOLD

The air injection system consists of the following parts (see figures 36-1 and 36-2):

- air pump
- diverter valve or anti-backfire valve
- air hoses
- check valves
- air manifold assembly
- air nozzles
- pressure relief valve
- intake manifold vacuum line

There are four main air injection systems. They are all very similar, differing only in their names and in their valve locations and arrangements. They are:

- Thermoactor (Ford)
- Air Guard (American Motors)
- Air Injection Reactor (General Motors)
- Air Injection System (Chrysler)

Each system includes a belt-driven air pump that supplies the system with low-pressure air. The diverter valve, sometimes called an air bypass valve, is an anti-backfire valve. It prevents backfire in the exhaust system during deceleration by diverting the air coming from the pump and sending it into the atmosphere. A pressure relief valve, located either in the diverter valve or on the air pump, relieves excess pump pressures.

Figure 36-3 Check Valves on 8-Cylinder Engine

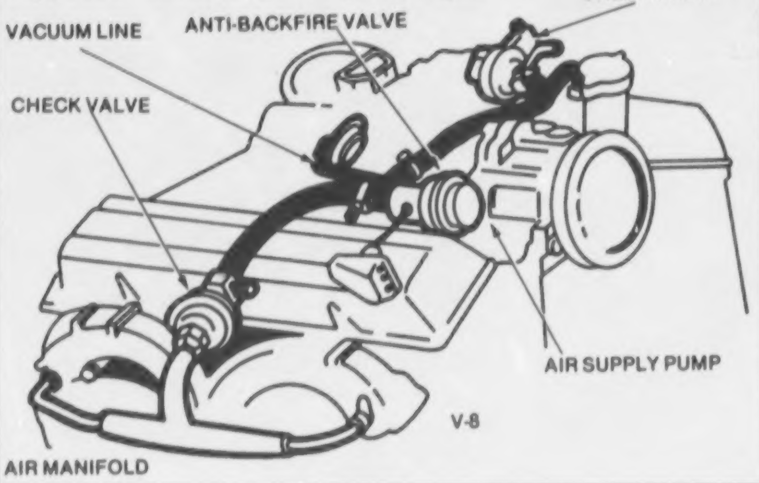
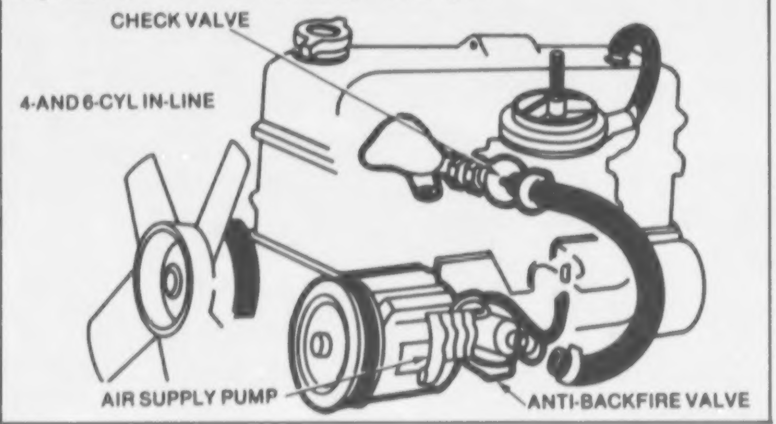

CHECK VALVE
VACUUM LINE
ANTI-BACKFIRE VALVE
CHECK VALVE
AIR SUPPLY PUMP
V-8
AIR MANIFOLD

Figure 36-4 Check Valves on 6-Cylinder Engine


CHECK VALVE
4-AND 6-CYL IN-LINE
AIR SUPPLY PUMP
ANTI-BACKFIRE VALVE

Check valves are located at the entrance to the air manifold assemblies. V-8 engines have two check valves, one for each manifold assembly (see figure 36-3). Six-cylinder engines have only one (see figure 36-4). The check valve is a one-way valve that prevents hot exhaust gases in the engine from backing up into the air pump. The air manifold assemblies and the air nozzles complete the plumbing by directing air into the engine exhaust ports.

After you have finished all the activities for Performance Objective 36, your instructor will use a checklist like the one on the following page to evaluate your work.

PERFORMANCE CHECKLIST—P.O. 36

The instructor will provide a vehicle that has an air injection system. Test the system and correct any problems you find. All of the performances below must be accomplished.

Student Performances	**Instructor Ratings**		
	Acceptable	Not Acceptable	Omit
1. Inspects the air injection system of a vehicle.			
2. Tests the air pump output of the air injection system.			
3. Tests the operation of the diverter valve of the air injection system.			
4. If available, tests the operation of the gulp valve of the air injection system.			
5. Tests the operation of the check valve of the air injection system.			
6. Removes, installs, and adjusts the air pump drive belt of an air injection system.			
7. Removes, services, and installs the air pump of an air injection system.			
8. Removes and installs the diverter valve of an air injection system.			
9. Removes and installs the check valve of an air injection system.			
10. Uses proper tools and equipment.			
11. Follows all appropriate safety precautions.			
12. Time.			

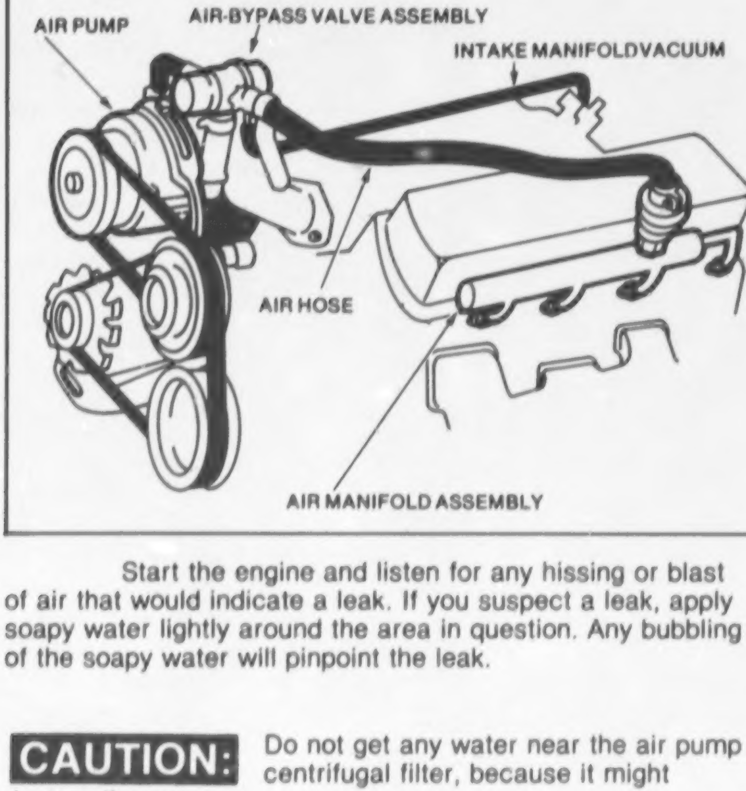
SAMPLE

Inspecting and Testing the Air Injection System

The air injection system should be inspected and checked for operation every 12,000 miles or every 12 months. Periodic maintenance of the system will help keep exhaust emissions at the required levels.

Air manifolds and hoses. Visually inspect the air manifold(s) and hoses for holes, cracks, fractures, kinks, sharp bends, and leaks. Check all connections for tightness (see figure 36-5).

Figure 36-5 Air Manifolds and Hoses



Start the engine and listen for any hissing or blast of air that would indicate a leak. If you suspect a leak, apply soapy water lightly around the area in question. Any bubbling of the soapy water will pinpoint the leak.

CAUTION: Do not get any water near the air pump centrifugal filter, because it might destroy the pump.

Look at the hoses near the check valves for signs that they have been burned. If they are burned, the hot exhaust gases from the engine are backing up past the check valve toward the air pump. The check valve, as well as the hose, should be replaced.

Air pump drive belt. Visually inspect the pump drive belt for wear, cracks, and deterioration. Replace it if it is defective.

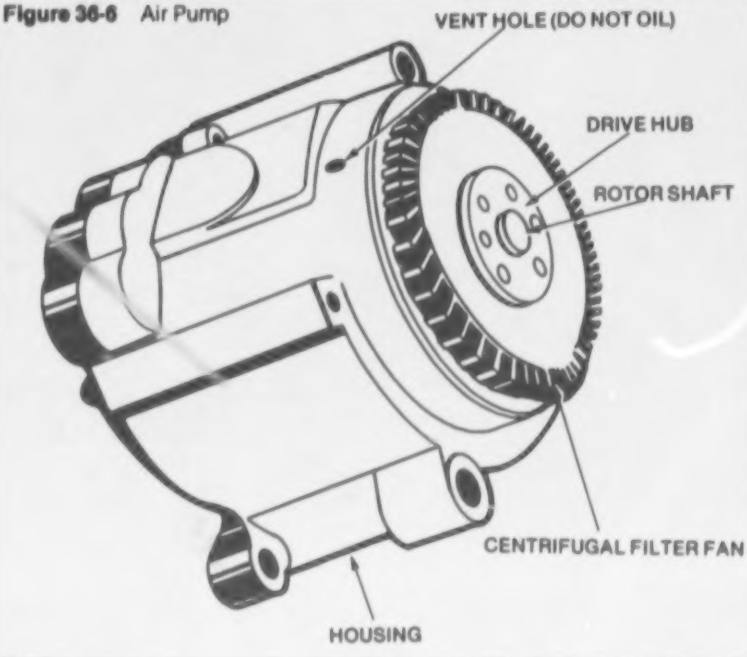
Check the drive belt for correct tension. Look in your technical service manual for the correct tension specifications and use a belt tension gauge to make adjustments.

Start the engine and listen for any excessive belt noise. A squealing belt could be caused by either a loose belt or a seized pump. Stop the engine and turn the pump pulley by hand. If you cannot turn the pulley, then the belt is slipping, causing the high squeal. The air pump is at fault and needs to be replaced.

NOTE: Air is drawn into the belt-driven pump from an external filter, from the air cleaner on the engine, or through a centrifugal fan filter mounted on the front of the pump. The air is then compressed slightly by the pump and delivered through the hoses and valves to the injection nozzles in the exhaust manifolds. Any breakdown in the delivery system directly affects the amount of afterburn of the hot exhaust gases and therefore the exhaust emission levels.

Air pump output. Visually inspect the air pump for defects. Check the mounting bolts and the belt tension adjusting bolt for tightness. The air pump must be securely mounted (see figure 36-6).

Figure 36-6 Air Pump



80

Start the engine and listen for excessive noise from the pump. Air pumps are normally noisy. As engine speed increases, the noise of the pump will rise in pitch. The rolling sound made by the pump bearings is okay unless the noise becomes objectionable at certain speeds. A continual knocking sound indicates that the pump rear bearing has failed. The pump will need to be replaced.

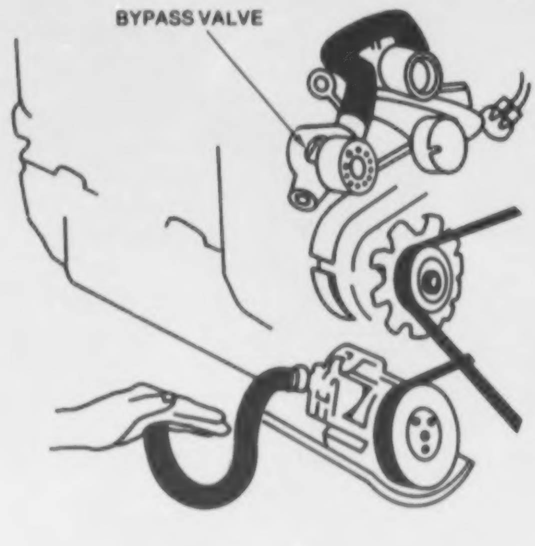
A continual hissing sound from the pressure relief valve (located on the pump) at idle indicates a defective valve. The valve will need to be replaced.

To check the pump air output:

STEP 1 Turn off the engine.

STEP 2 Disconnect the air hose from the anti-backfire valve (diverter valve).

Figure 36-7 Checking Hose When Removed from Bypass Valve



- On some air injection systems, you'll need to remove the hose from the bypass valve (see figure 36-7).

STEP 3 Start the engine. Check the air flow from the air pump at the outlet.

STEP 4 Accelerate the engine to approximately 1500 RPM. The air flow should increase as the engine speed increases.

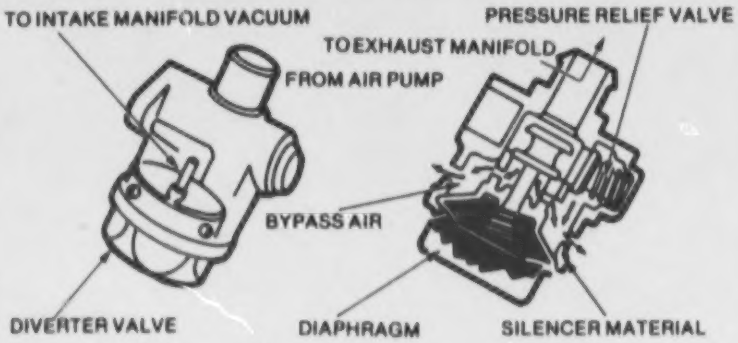
- If the air flow does not increase, check for air coming from the diverter valve muffler. The diverter valve should be replaced if air is escaping from the valve at idle speed.
- If the air pump is not increasing the air flow as described, the pump should be replaced.

NOTE: These are basic air pump tests. Check your technical service manual for exact testing procedures for the make and model of the vehicle you are working on.

STEP 5 Turn off the engine. Reconnect the hose and tighten the hose clamp.

Diverter valve. Injecting air into the exhaust port works fine when the vehicle is operating at speed or is accelerating, but it will cause backfiring upon deceleration unless something else is added to the system. The diverter valve, by-pass valve, and gulp valves are all anti-backfire valves (see figure 36-8). They operate only during periods of deceleration and during sudden increases in intake manifold vacuum. For these reasons, there is a vacuum sensing line to the diverter valve from the intake manifold.

Figure 36-8 External and Internal View of Diverter Valve



The diverter valve cuts off air to the exhaust ports and dumps it into the atmosphere during engine deceleration when the air-fuel mixture is rich. Without this process, the engine would backfire.

To test the diverter valve:

STEP 1 Start the engine and warm it up to operating temperatures.

STEP 2 Disconnect the vacuum sensing line at the diverter valve and check it for vacuum by placing your finger over the end of the line. You should feel a vacuum pull on your finger. If you can't feel a vacuum, check the line for kinks, cracks, or loose connections.

STEP 3 Reconnect the vacuum line. Check the diverter valve muffler to be sure that air is not escaping.

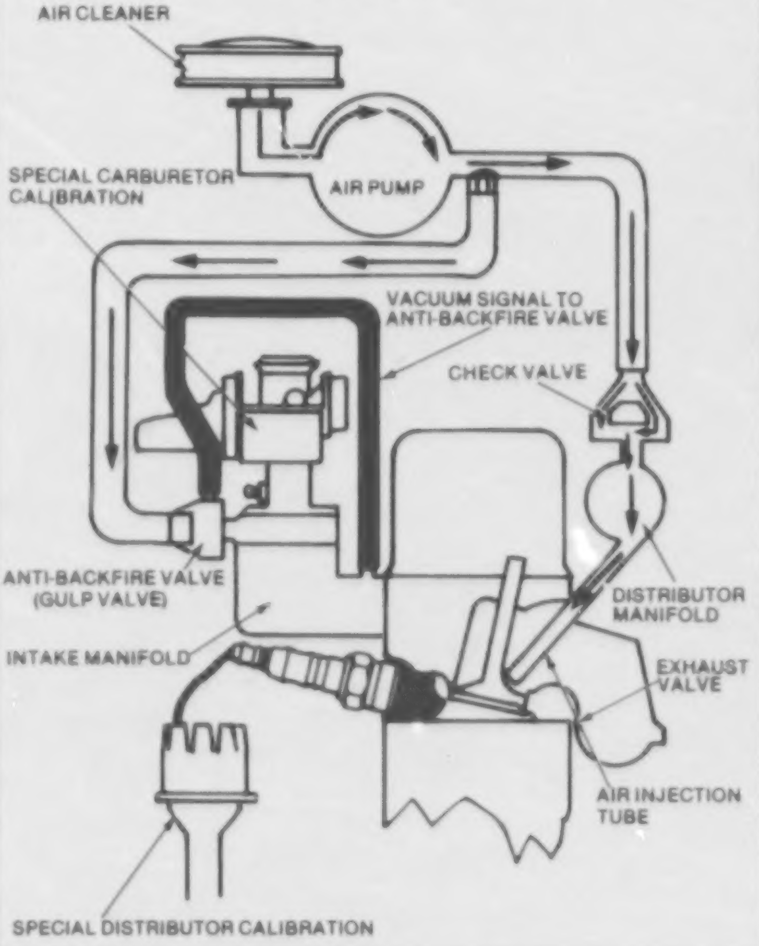
- If air is escaping, there could be a restriction in the hoses and lines that is causing the pressure relief valve to open. (In figure 36-8, the pressure relief valve for the air injection system is located in the diverter valve.) If no restrictions are apparent, replace the diverter valve.

STEP 4 Place your hand by the diverter valve muffler. Open and close the throttle quickly. A blast of air should come out of the muffler for approximately one second. If air doesn't come out of the diverter valve, the valve is defective and should be replaced.

NOTE: These are basic diverter valve tests. Check your technical service manual for exact testing procedures for the make and model of the vehicle you are working on.

The air injection systems on some older vehicles (for example, 1967 vehicles) use a gulp valve as an anti-backfire valve. Instead of dumping air into the atmosphere during deceleration, the gulp valve injects additional air into the intake manifold. This leans out the air-fuel mixture that, in turn, prevents engine backfire. To identify a gulp valve system, look for a large hose extending from the anti-backfire valve to the intake manifold (see figure 36-9).

Figure 36-9 Gulp Valve Air Injection System


AIR CLEANER
SPECIAL CARBURETOR CALIBRATION
AIR PUMP
VACUUM SIGNAL TO ANTI-BACKFIRE VALVE
CHECK VALVE
ANTI-BACKFIRE VALVE (GULP VALVE)
INTAKE MANIFOLD
DISTRIBUTOR MANIFOLD
EXHAUST VALVE
AIR INJECTION TUBE
SPECIAL DISTRIBUTOR CALIBRATION

To test the operation of the gulp valve:

STEP 1 Disconnect the air hose between the pump and the gulp valve.

STEP 2 Operate the engine at 1500-2000 RPM and allow the throttle to *snap* closed. This should produce a loud sucking sound in the gulp valve.

STEP 3 Repeat the test several times. If no sound is heard from the gulp valve, the valve should be replaced.

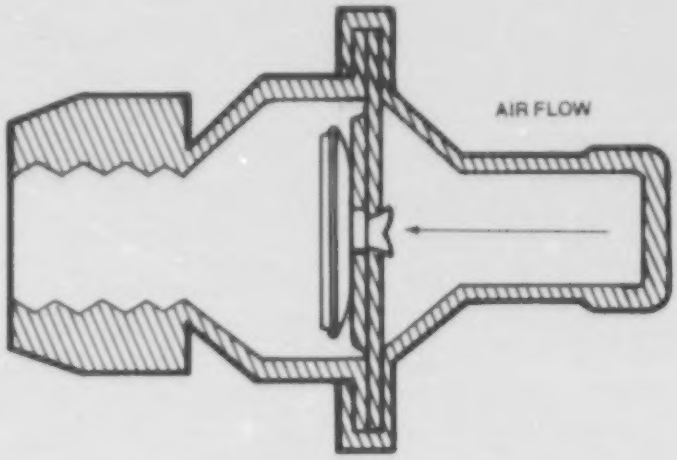
STEP 4 Reconnect the hose and tighten the clamp.

- On 1975 Ford vehicles equipped with a catalytic converter, a vacuum differential valve (VDV) is used with the bypass valve. Its purpose is to block the vacuum signal to the bypass valve, causing it to dump air from the pump into the atmosphere. Always check the vehicle manufacturer's exact testing procedures when working with air injection systems that differ slightly from common systems.

Testing the check valve. To test the operation of this valve:

STEP 1 Visually check for exhaust gases leaking through the check valve. Look for a burned hose; a burned hose would indicate an exhaust leak (see figure 36-10).

Figure 36-10 Check Valve Assembly



NOTE: The check valve is a one-way valve that allows air to flow in one direction only.

STEP 2 Start the engine. With the engine operating, disconnect the air hose from the check valve (work from the air-pump side of the valve.)

STEP 3 Operate the engine at 1500 RPM and look for exhaust gas leakage at the valve. If leakage is present, replace the check valve.

STEP 4 Turn off the engine and reconnect the air hose to the check valve. Be sure to tighten the clamp securely.

NOTE: These are basic check valve testing procedures. Check your technical service manual for exact procedures for the make and model of the vehicle you are working on.

Use the troubleshooting chart below to diagnose air injection system troubles.

Condition	Possible Cause	Correction
excessive belt noise	(a) loose belt	(a) Tighten the belt.
	(b) seized pump	(b) Replace the pump.
excessive pump noise: chirping	insufficient break-in	Recheck for noise after 1000 miles of operation.
excessive pump noise: chirping, rumbling, or knocking	(a) leak in hose	(a) Locate the source of the leak using soap solution, and correct it.
	(b) loose hose	(b) Reassemble and replace the hose clamp, or tighten it.
	(c) hose touching other engine parts	(c) Adjust the hose position.

Condition	Possible Cause	Correction
	(d) inoperative diverter valve	(d) Replace the diverter valve.
	(e) inoperative check valve	(e) Replace the check valve.
	(f) loose pump mounting fasteners	(f) Tighten the mounting screws as specified.
	(g) pump failure	(g) Replace the pump.
no air supply: accelerate engine to 1500 RPM and observe air flow from hoses. If the flow increases as the RPMs increase, the pump is functioning normally. If not, check for possible causes.	(a) loose drive belt	(a) Tighten the belt to specifications.
	(b) leaks in supply hose	(b) Locate the [illegible] and repair or replace the hose as required.
	(c) leak at fitting(s)	(c) Tighten or replace the clamps.
	(d) leak in diverter valve	(d) If air is expelled through the diverter exhaust with vehicle at idle, replace the diverter valve.

Adapted from *1975 Emission Controls*, Chrysler Motor Corporation.

Turn to your Review Exercise Book and complete Exercise 8.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin any of these work activities until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

1. Look at the air injection system in several vehicles and identify the main parts of the system for each vehicle (pages 73-75).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

2. Inspect and test the operation of these components of an air injection system:
   - air manifolds and hoses
   - air pump drive belt
   - air pump output
   - diverter valve
   - check valve

Write down any defects you find (pages 77-85).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

After you have finished these activities, go on to the next section.

Servicing An Air Injection System

A defective part in an air injection system is normally replaced rather than repaired. Here are some other points to keep in mind.

- Do not oil the air pump.
- If there's an external filter, it should be cleaned. Late model pumps have a service-free centrifugal filter fan on the front of the pump.
- The air nozzles should be serviced or replaced if they become plugged with carbon deposits.

Air manifolds and hoses. If you find a cracked or damaged manifold, replace the part. Cracked, burned, or deteriorated hoses should also be replaced. Be sure all connections are securely tightened.

After you replace any manifolds or hoses, always make an operational check of the air injection system. Start the engine and check the connections for leaks.

Air pump drive belt. Replacement of an air pump drive belt requires the same general procedures as the replacement of an alternator belt.

To replace the air pump belt:

STEP 1 Loosen both the belt-adjusting bolt and the air pump mounting bolt.

STEP 2 Pivot the air pump toward the crankshaft pulley and work the belt off the pulleys.

STEP 3 Install the new air pump belt around the pulleys and adjust the belt to the belt tension specifications, using a belt tension gauge.

- Whether the air pump belt needs to be replaced or adjusted, always look up the belt tension specifications for it in your technical service manual.

STEP 4 When you adjust the belt, always pry against the rear cover of the air pump only.

STEP 5 Tighten the air pump belt-adjusting bolt and the mounting bolt securely.

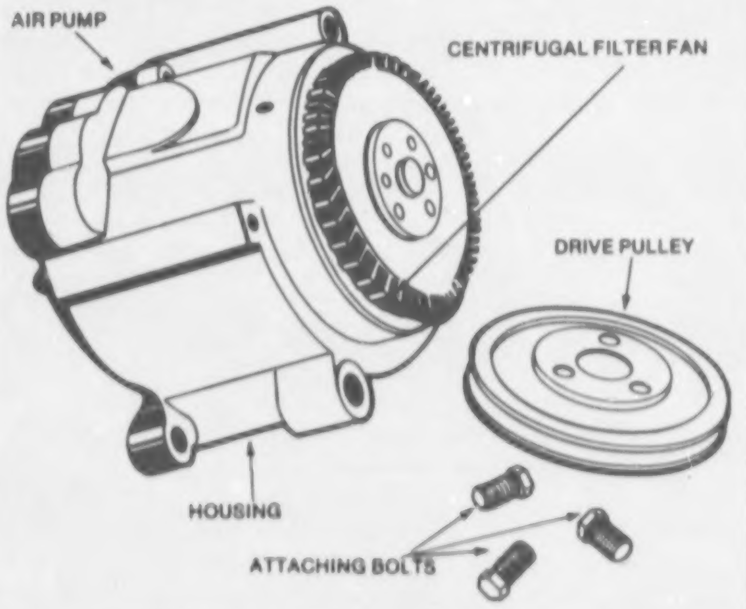
Air pump. Servicing the air pump can include replacing the centrifugal filter fan, a pressure relief valve, or the entire pump assembly. The air pump is usually not disassembled for overhaul or parts-replacement purposes.

To replace the centrifugal filter fan:

STEP 1 Loosen the air pump adjusting bolt and its mounting bolt. Remove the drive belt.

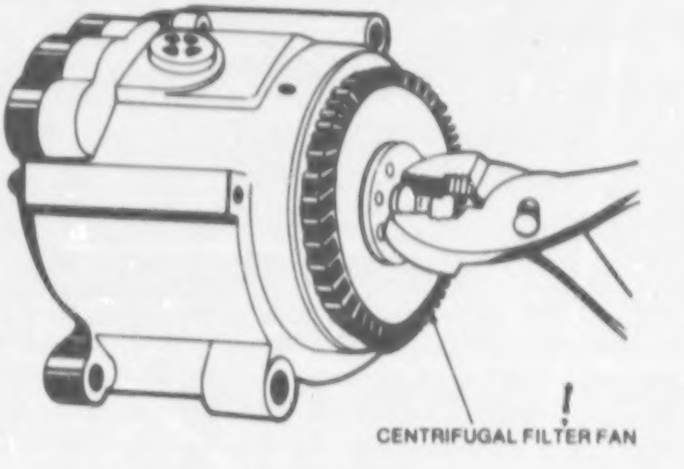
STEP 2 With the air pump on the vehicle, remove the three drive pulley attaching bolts. Pull the drive pulley off the pump shaft (see figure 36-11).

Figure 36-11 Air Pump with Drive Pulley Disconnected


AIR PUMP
CENTRIFUGAL FILTER FAN
DRIVE PULLEY
HOUSING
ATTACHING BOLTS

STEP 3 Pry the outer disc loose, and pull off the centrifugal filter fan with slip-joint pliers (see figure 36-12).

Figure 36-12 Removing the Centrifugal Filter Fan


CENTRIFUGAL FILTER FAN

90

- If the fan breaks during removal, make sure that fragments don't enter the air-intake hole.

STEP 4 Install the new filter fan and the old pulley on the air pump shaft. Install the three bolts.

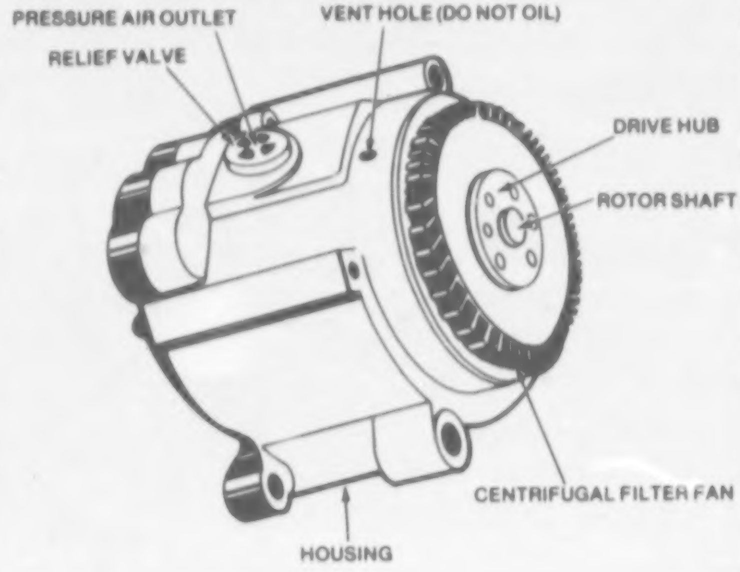
STEP 5 Draw the fan and pulley onto the shaft by alternately tightening the bolts. Be sure the outer edge of the fan slips into the housing.

NOTE: A slight amount of interference with the bore is normal. After a new fan is installed, it may be noisy until its outer diameter lip has worn in. This may require 20 to 30 miles of operation.

STEP 6 Use an inch-pound torque wrench to tighten the pulley screws securely. They should be tightened to about 90 in.-lbs. Check your technical service manual for exact specifications for the year and model of the vehicle that you are repairing.

The pressure relief valve can be replaced only if the valve is mounted in the pump housing (see figure 36-13). To replace the pressure relief valve:

Figure 36-13 Air Pump with Relief Valve



STEP 1 Remove the air pump from the vehicle and place it on a workbench.

CAUTION: Do not clamp the air pump in a vise to hold it. You can crush it very easily.

- To remove the air pump, disconnect the air outlet house and the vacuum sensing line from the diverter valve. Remove the pump belt-adjusting bolt. Loosen the mounting bolt and remove the belt from the pump pulley. Remove the air pump mounting bolt and the air pump from the vehicle.

STEP 2 Use a steel bridge and a gear puller to remove the pressure relief valve (see figure 36-14).

Figure 36-14 Using Steel Bridge and Gear Puller to Remove the Pressure Relief Valve

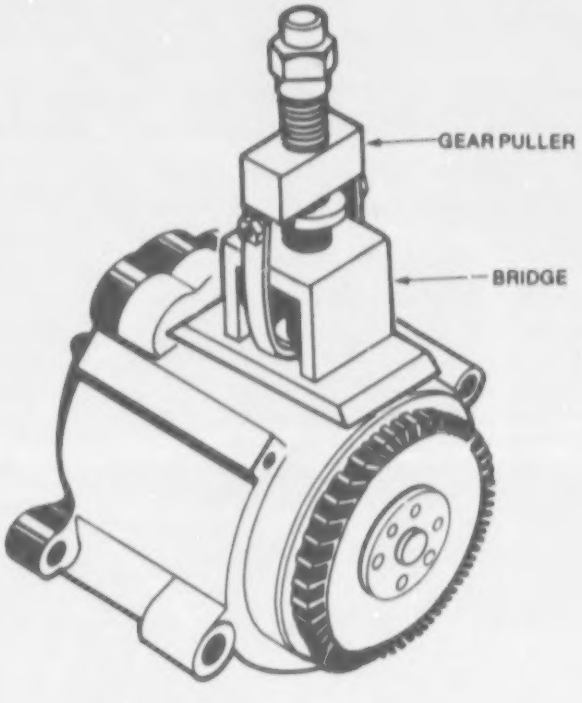
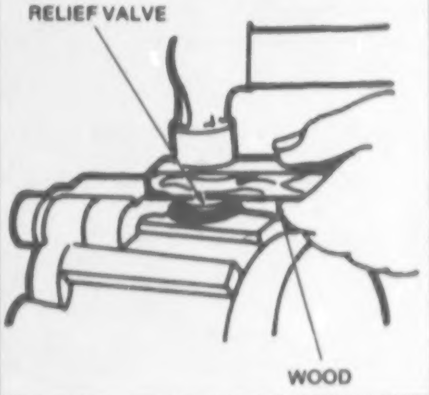


Figure 36-15 Installing a New Valve



STEP 3 To install a new valve, insert it into its mounting hole. Place a block of wood over the valve and tap the wood lightly with a hammer until the shoulders of the valve fit flush against the pump housing (see figure 36-15).

CAUTION: There is sometimes a pressure-setting plug installed in the relief valve. Remove this plug before you install the valve; the plug is made of plastic and breaks easily.

After the valve is installed, insert the pressure plug and press it into place by pushing against its center.

To replace the pressure-setting plug in the pressure relief valve:

- Press the locking tabs together (inward) and remove the plastic pressure-setting plug.
- Before you install a new plug, be sure it is the correct color. Look in your technical service manual for the application color codes.
- Insert the new plug in the pressure relief valve hose and push the plug in until it snaps into place.

STEP 4 Reinstall the air pump in the vehicle. Be sure the belt is adjusted to the proper belt-tension specifications.

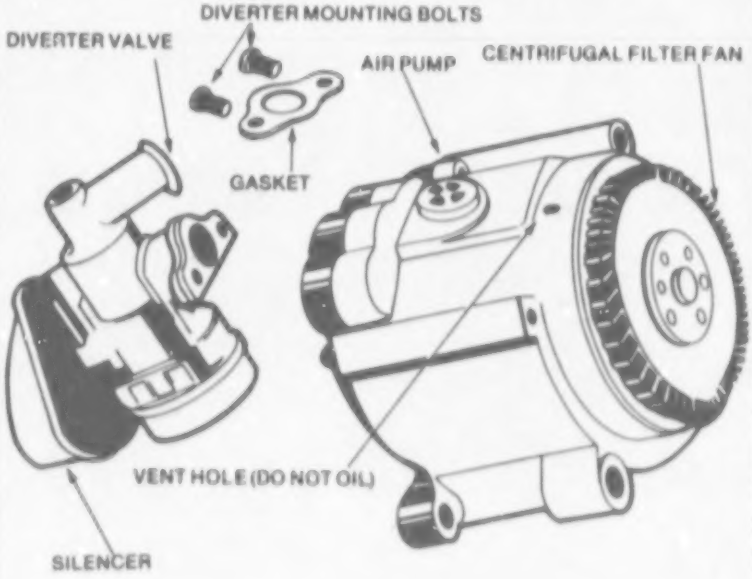
STEP 5 Perform an operational check on the air injection system after you replace a pressure relief valve or an air pump.

Diverter valve. If the diverter valve is defective, it should be replaced. To replace the valve:

STEP 1 Disconnect the outlet air hose and the vacuum sensing line from the diverter.

STEP 2 Remove the two mounting bolts that attach the diverter to the air pump (see figure 36-16).

Figure 36-16 Air Pump with Diverter Mounting Bolts Removed


DIVERTER MOUNTING BOLTS
DIVERTER VALVE
AIR PUMP
CENTRIFUGAL FILTER FAN
GASKET
VENT HOLE (DO NOT OIL)
SILENCER

STEP 3 Remove the diverter and its gasket from the air pump.

STEP 4 To install a new diverter valve, follow the removal steps in reverse order.

NOTE: Removal procedures for gulp valves and bypass air valves are in your technical service manual.

STEP 5 Perform an operational check on the air injection system after you replace a diverter valve.

Check valves. If a check valve is leaking exhaust gases, it should be replaced. A burned air hose is also an indication of a defective check valve. To replace a check valve:

STEP 1 Disconnect the air hose from the check valve. Loosen the hose clamp and pull the hose away from the check valve.

STEP 2 With wrenches of the proper size, remove the check valve from the air manifold, (see figure 36-17) or the exhaust manifold (see figure 36-18).

Figure 36-17 V-8 Engine with Air Hose Disconnected

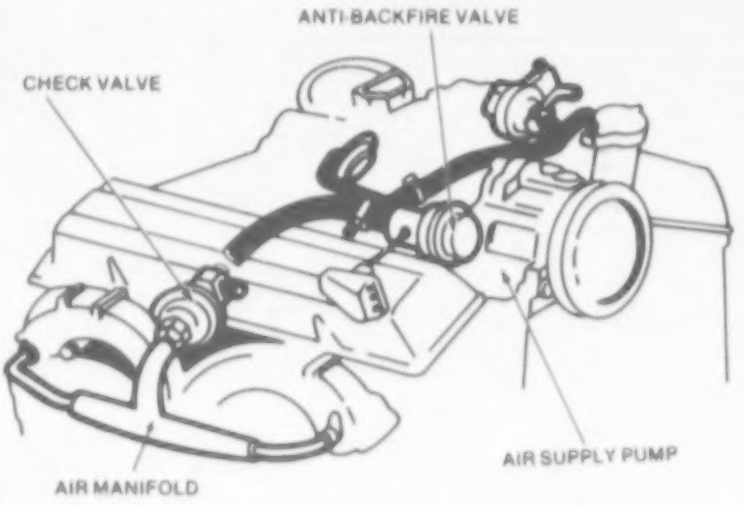
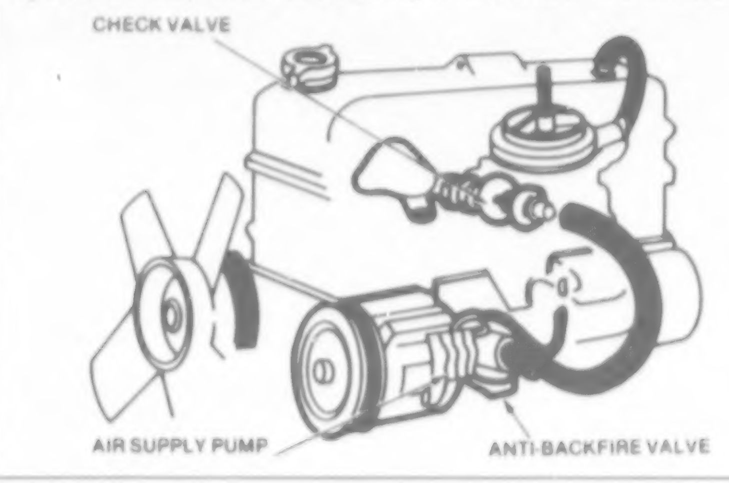

ANTI-BACKFIRE VALVE
CHECK VALVE
AIR SUPPLY PUMP
AIR MANIFOLD

Figure 36-18 4-Cylinder or 6-Cylinder Engine with Air Hose Disconnected


CHECK VALVE
AIR SUPPLY PUMP
ANTI-BACKFIRE VALVE

STEP 3 Install a new check valve by following the removal procedures in reverse order.

STEP 4 Perform an operational check on the air injection system after you replace a check valve.

Turn to your Review Exercise Book and complete Exercise 9.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin any of the work activities until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

3. Remove and install an air injection air pump (pages 87-91).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

4. Remove and install an air injection diverter valve (pages 91-92).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

5. Remove and install an air injection check valve (pages 92-93).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

6. Do an operational check of an air injection system after you complete any parts replacements (pages 77-85).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

When you have finished these activities, ask your instructor to return your pretest on Performance Objective 36. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 37

INSPECT, TEST, AND SERVICE EXHAUST GAS RECIRCULATION SYSTEMS

INTRODUCTION

The exhaust gas recirculation system is an exhaust emission control system that came into use throughout the industry in 1973. Popularly known as the EGR system, its purpose is to redirect a small amount of the engine exhaust gases to the intake manifold where it is mixed with the air-fuel mixture. This dilutes the air-fuel mixture and thus lowers the high temperature developed in the combustion chamber. The lower temperature reduces the formation of NOx (nitrogen oxide) emissions.

After you have finished all the activities for Performance Objective 37, your instructor will use a checklist like the one on the following page to evaluate your work.

PERFORMANCE CHECKLIST—P.O. 37

The instructor will provide a vehicle that has an EGR system. Test the system and correct any problems you find. All of the performances below must be accomplished.

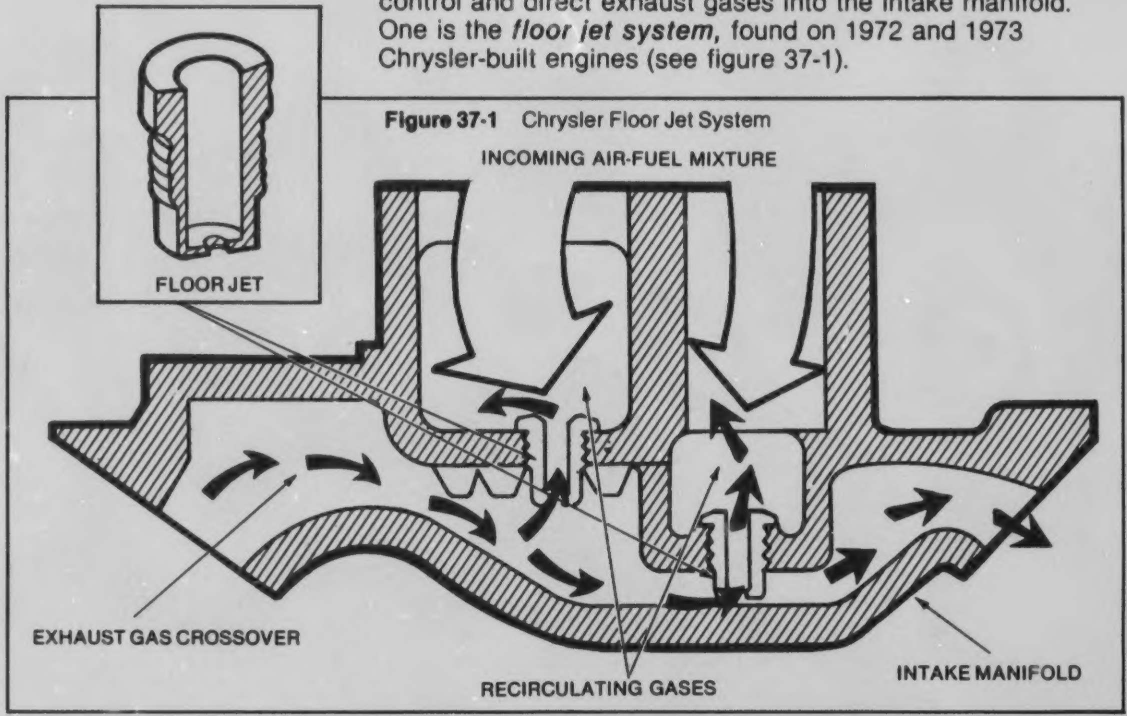
Student Performances	**Instructor Ratings**		
	Acceptable	Not Acceptable	Omit
1. Inspects an exhaust gas recirculation (EGR) valve-controlled system.			
2. If available, inspects an exhaust gas recirculation (EGR) floor-jet system on a Chrysler-made vehicle.			
3. Tests the operation of an EGR, valve-controlled system: EGR coolant control valve EGR valve EGR carburetor ports EGR venturi vacuum amplifier			
4. If available, removes and installs an EGR floor jet of a Chrysler-made vehicle.			
5. Removes and installs an EGR coolant control valve.			
6. Removes and installs an EGR valve.			
7. Removes and installs an EGR venturi vacuum amplifier.			
8. Resets an EGR maintenance reminder system of a Chrysler-made vehicle.			
9. Uses proper tools and equipment.			
10. Follows all appropriate safety precautions.			
11. Time.			

SAMPLE

Types of EGR Systems

There are two types of systems currently used to control and direct exhaust gases into the intake manifold. One is the *floor jet system,* found on 1972 and 1973 Chrysler-built engines (see figure 37-1).

Figure 37-1 Chrysler Floor Jet System



It consists of metered jets threaded into the intake manifold below the carburetor. The jets allow the exhaust gases to enter the intake passages from the exhaust crossover in the intake manifold. The amount of exhaust gas drawn into the intake system is controlled by the engine manifold vacuum and by the size of the jet orifice.

The other EGR system, a *valve-controlled system* (see figure 37-2), is now the most popular one for all engines. This system uses a spring-loaded poppet valve that is operated by vacuum from the carburetor. The vacuum-operated EGR valve controls the amount of exhaust gas entering the intake manifold. The spring keeps the valve closed while the carburetor vacuum opens.

Figure 37-2 EGR Valve-Controlled System

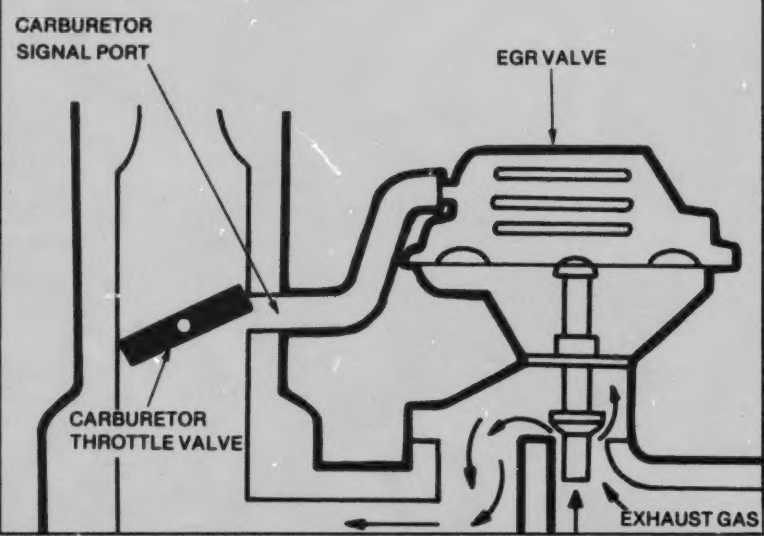
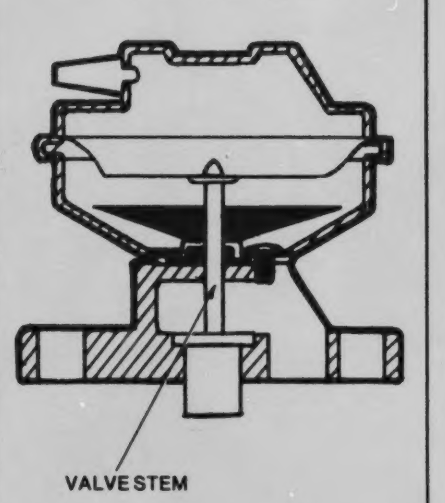

CARBURETOR SIGNAL PORT
EGR VALVE
CARBURETOR THROTTLE VALVE
EXHAUST GAS

Figure 37-3 Cutaway of EGR Valve with Valve Stem Enclosed



You'll find EGR valves mounted on the intake manifold (see figures 37-3 and 37-4) or on a plate under the carburetor (see figures 37-5 and 37-6).

Figure 37-4 EGR Valve on Intake Manifold with Valve Stem Exposed

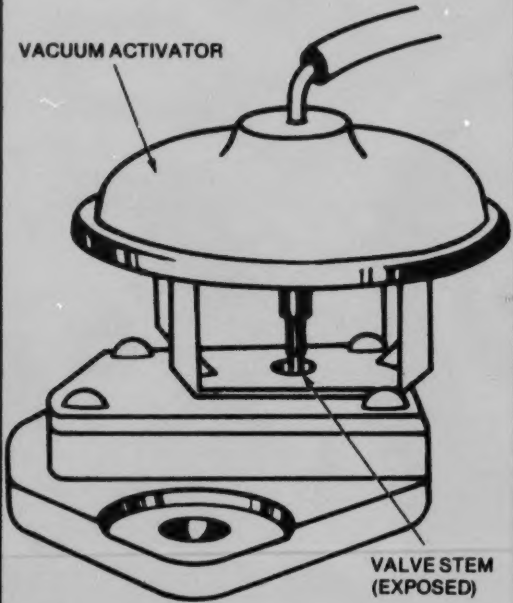

VACUUM ACTIVATOR
VALVE STEM (EXPOSED)

Figure 37-5 EGR Valve Mounted on Carburetor Plate or Spacer

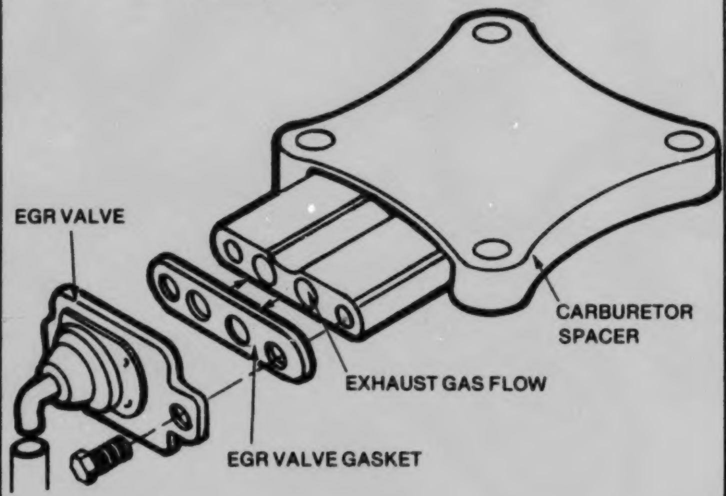
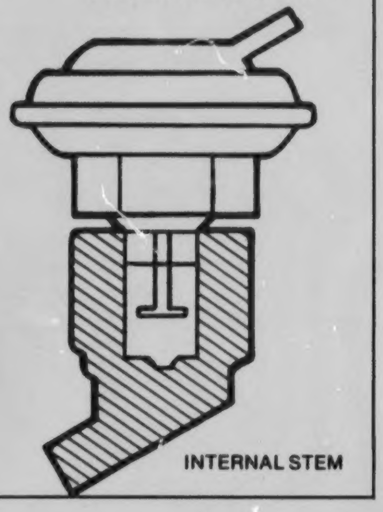

EGR VALVE
CARBURETOR SPACER
EXHAUST GAS FLOW
EGR VALVE GASKET

Figure 37-6 Cutaway of EGR Valve Mounted on Carburetor Plate with Internal Valve Stem

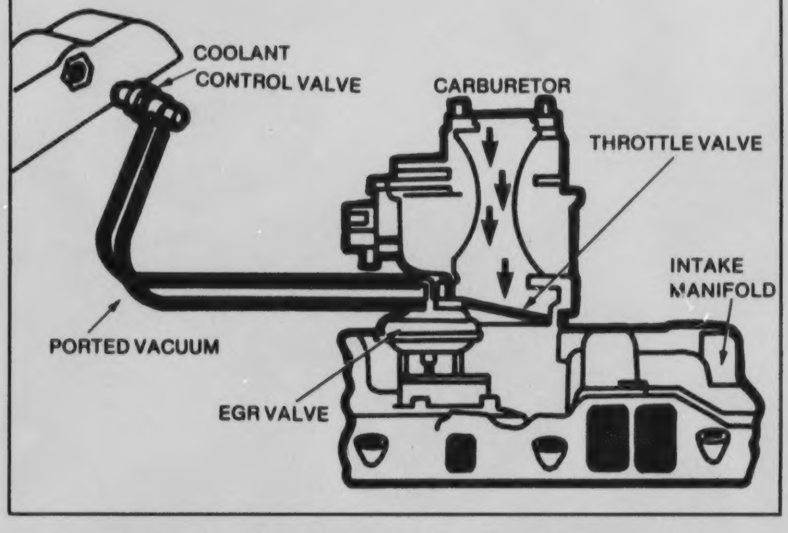

INTERNAL STEM

The vacuum-controlled EGR system thus relies upon carburetor vacuum to operate the EGR valve. However, the method used to control the vacuum varies among vehicle manufacturers as each tries to achieve the best balance between low NOx emissions and engine operating performance and economy.

Ported Vacuum-Exhaust Gas Recirculation System

Figure 37-7 shows this system.

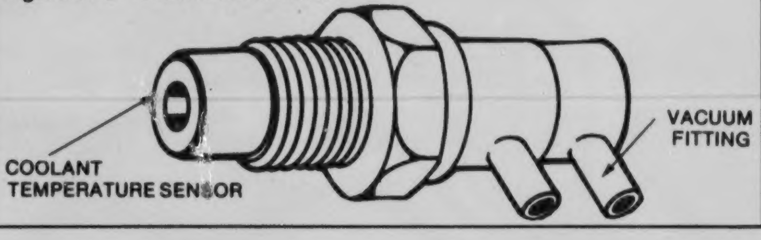
Figure 37-7 Ported Vacuum-Exhaust Gas Recirculation System


COOLANT CONTROL VALVE
CARBURETOR
THROTTLE VALVE
INTAKE MANIFOLD
PORTED VACUUM
EGR VALVE

Ported refers to the carburetor signal port in the carburetor throttle body. The vacuum line is connected to this port, where it is exposed to increasing manifold vacuum as the throttle valve opens. The system consists of:

Coolant control valve. This valve is usually located in the radiator top tank. Its purpose is to prevent vacuum from reaching, and therefore operating, the EGR valve until the coolant temperature is about 60°F. The coolant control valve is also called a temperature-controlled vacuum valve (see figure 37-8).

Figure 37-8 Coolant Control Valve


COOLANT TEMPERATURE SENSOR
VACUUM FITTING

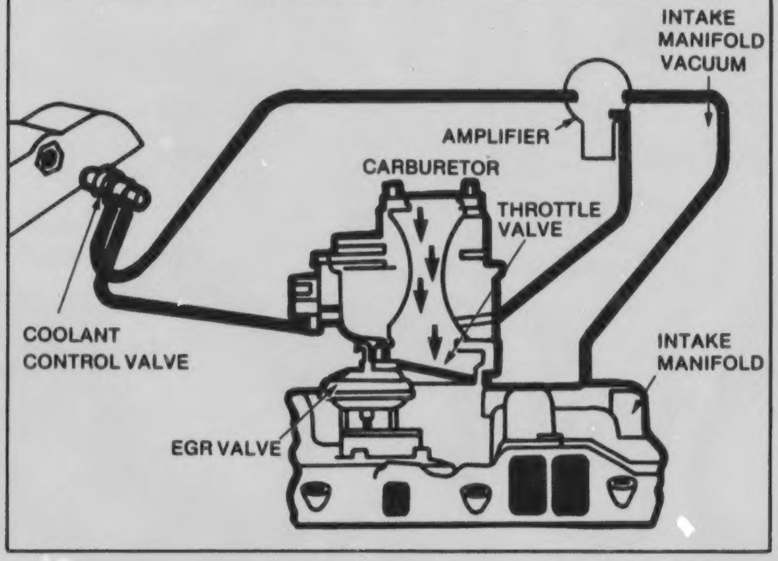
EGR valve. This valve opens or meters the exhaust gas flow into the intake manifold.

Intake manifold. This component contains specially cast exhaust passages that connect on the intake side by way of the EGR valve.

Venturi Vacuum-Exhaust Gas Recirculation System

Figure 37-9 shows this system.

Figure 37-9 Venturi Vacuum-Exhaust Gas Recirculation System



The vacuum signal in this system is received from the carburetor venturi, is sent to an amplifier, and then on to the control valve. The system consists of these components:

Venturi vacuum signal tap. This is the opening in the carburetor through which the relatively weak vacuum signal from the throat of the carburetor venturi is sent to the amplifier.

Amplifier. This uses the weaker venturi-vacuum signal to control the stronger intake manifold vacuum needed to control the EGR valve.

Coolant control valve. Located in the radiator top tank, the valve prevents vacuum from reaching and operating the EGR valve until the coolant temperature is about 60°F.

EGR valve. This valve opens, or meters, the exhaust gas flow into the intake manifold.

Intake manifold. The manifold contains specially cast exhaust passages that are connected to the intake side by way of the EGR valve.

Operation of the EGR System

- When the engine is started (cold) and the radiator top tank temperature is below 60°F., the coolant control valve prevents vacuum from reaching the EGR valve. This improves cold engine performance.
- When the radiator top tank temperature (coolant) reaches approximately 60°F., the coolant control valve opens and allows vacuum to reach the EGR valve.
- As engine speed is increased and approximately 3 to 5 inches of vacuum is developed at the carburetor signal port, the EGR valve begins to open. This allows the exhaust gas to mix with and dilute the incoming air-fuel mixture.
- As acceleration is increased, the manifold vacuum at the carburetor-signal port increases. At between 5 and 8 inches of vacuum, the maximum flow of exhaust gases occurs through the EGR valve.
- At wide-open throttle, the manifold vacuum drops below the minimum vacuum needed to open the EGR valve. No exhaust gas recirculation takes place.
- At idle, the throttle valve position is below the carburetor signal port and no exhaust gas recirculation takes place.

The EGR system does ***not*** operate at idle, at wide-open throttle, or during engine warm-up (with a cold engine).

Remember that maximum exhaust gas recirculation is needed during cruising and acceleration (30 to 70 miles per hour), because NOx is highest at these operating ranges. If the EGR system worked at idle, at high-speed operation (wide-open throttle), and at low engine-operating temperatures, engine efficiency would be affected. A malfunctioning EGR system may cause:

- hard starting or no starting
- rough idle
- stalling, hesitation, surge
- poor fuel economy

Turn to your Review Exercise Book and complete Exercise 10.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to the work activity. Do not begin the work activity until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

1. Look at the exhaust gas recirculation system in several vehicles and identify the main parts of each system (pages 99-102).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

After you have finished this activity, go on to the next section.

Inspecting and Testing the EGR System

When you inspect, test, or service an exhaust gas recirculation system, always look up the particular vehicle's system in your technical service manual for specific procedures and specific specifications. EGR systems are not all alike. They differ in the kinds of vacuum controls used, and each requires a different checking procedure.

The complete EGR system should be inspected and tested every 10,000 to 20,000 miles, depending on the vehicle make.

Floor jet systems (Chrysler-built engines). It is not necessary to test a floor jet system. After the first 24,000 miles, inspect the floor jets for deposit buildup (see figure 37-10).

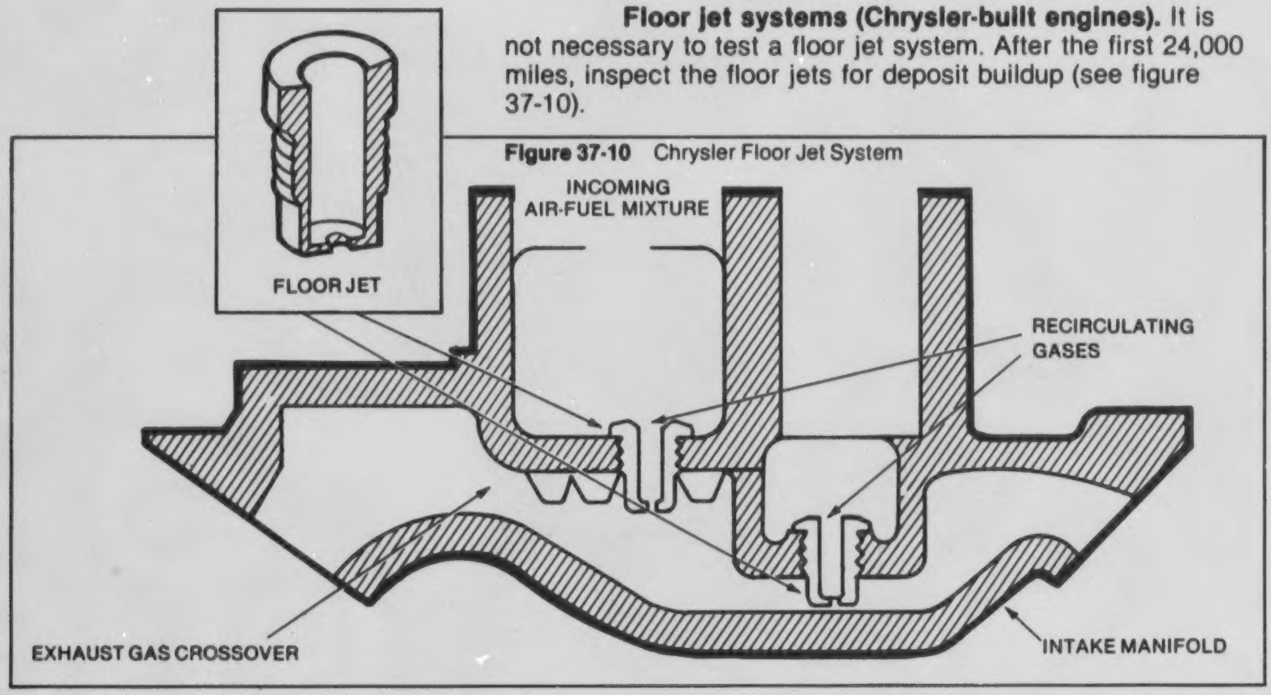


Figure 37-10 Chrysler Floor Jet System

STEP 1 With the engine turned off, remove the carburetor air cleaner. Block the choke and throttle valves open.

STEP 2 Use a flashlight to visually inspect the floor jets through the carburetor.
- If the jets are open, no service is required.
- If the jets are plugged, remove the carburetor and the floor jets. Clean the floor jets.
- Inspect and clean the jets every 12,000 miles, if necessary.

EGR valve-controlled systems. To assure that this EGR system functions properly, keep all passages and moving parts free from plugging or sticking caused by deposits. It is also important that the hoses and connections be free from leaks (see figures 37-11 and 37-12).

STEP I Inspect all hoses for hardness, cracks, and leaks. Check the hoses for restrictions, faulty connectors, and incorrect routing. Replace any defective hoses and connectors you find.

Figure 37-11 Vacuum Hose Disconnected: V-8 Engine

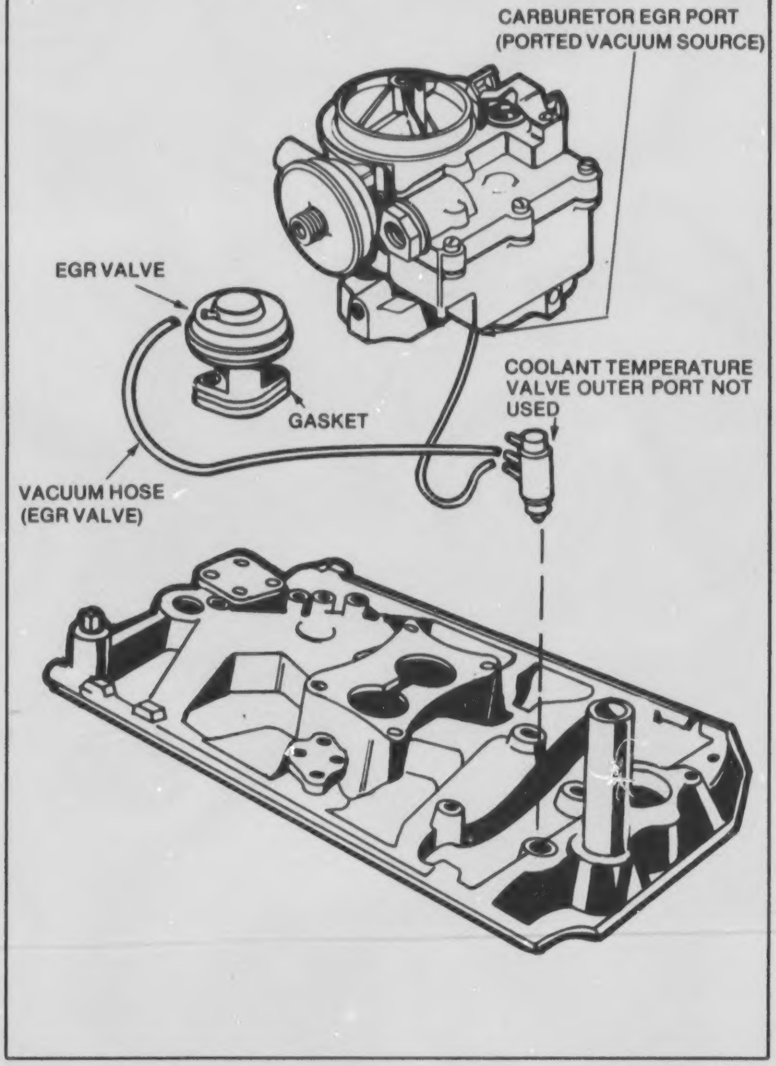
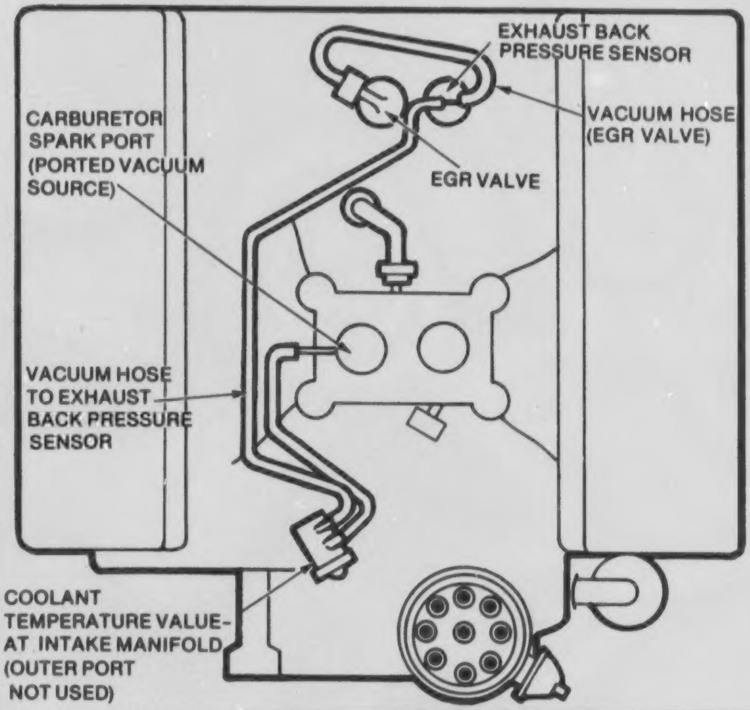
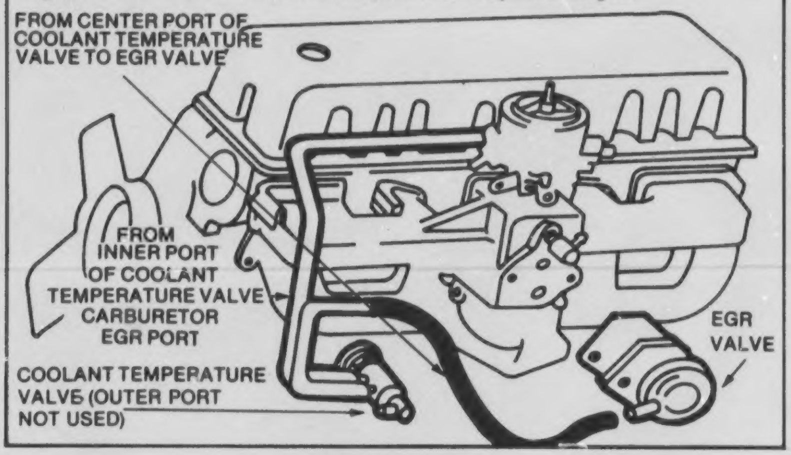

CARBURETOR EGR PORT
(PORTED VACUUM SOURCE)
EGR VALVE
COOLANT TEMPERATURE
VALVE OUTER PORT NOT
USED
GASKET
VACUUM HOSE
(EGR VALVE)

Figure 37-12 Routing of Vacuum Hoses Connected to EGR Components: V-8 Engine


EXHAUST BACK PRESSURE SENSOR
CARBURETOR SPARK PORT (PORTED VACUUM SOURCE)
VACUUM HOSE (EGR VALVE)
EGR VALVE
VACUUM HOSE TO EXHAUST BACK PRESSURE SENSOR
COOLANT TEMPERATURE VALUE-AT INTAKE MANIFOLD (OUTER PORT NOT USED)

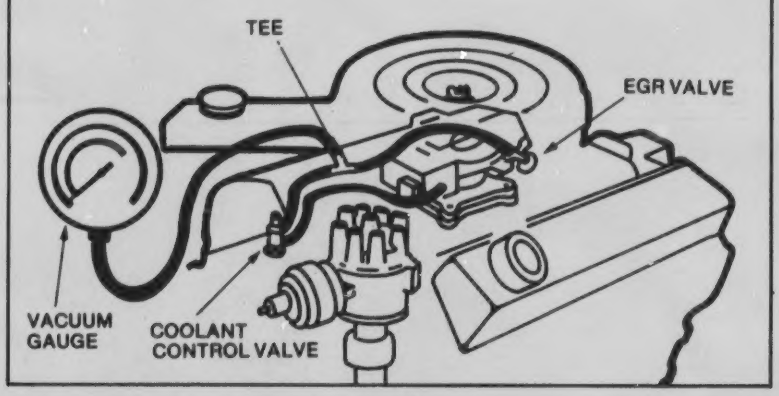
STEP 2 Inspect all hose connections between the carburetor, EGR valve, amplifier, and the coolant valve (see figure 37-13). Look up the vehicle's EGR system in the technical service manual and find out what other vacuum controls are involved.

Figure 37-13 Vacuum Hose on 6-Cylinder or 4-Cylinder Engine


FROM CENTER PORT OF COOLANT TEMPERATURE VALVE TO EGR VALVE
FROM INNER PORT OF COOLANT TEMPERATURE VALVE CARBURETOR EGR PORT
EGR VALVE
COOLANT TEMPERATURE VALVE (OUTER PORT NOT USED)

STEP 3 Attach a tachometer to the engine. Then connect a vacuum gauge to the hose leading to the EGR valve. To do this, disconnect the hose from the EGR valve and insert a tee in the hose (see figure 37-14).

Figure 37-14 Connecting a Vacuum Gauge with a Tee



EGR Coolant Control Valve Test

STEP 4 Look in your technical service manual for the EGR coolant control valve temperature specification for the vehicle year, make, and model.

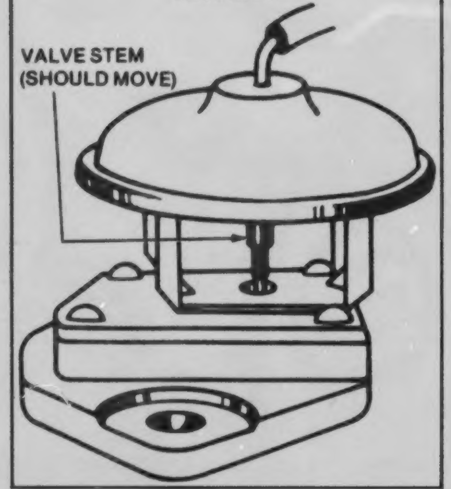
STEP 5 Begin the EGR system test with a cold engine. Start the engine and look at the vacuum gauge reading. There should be no vacuum reading if the coolant control valve is operating properly. Operate the engine at 2000 RPM.

GOOD If the vacuum gauge reading is zero, the coolant control valve is okay.

BAD If there is any vacuum reading, the coolant control valve should be replaced.

STEP 6 Operate the engine at 2000 RPM until the coolant temperature rises above the specified temperature. (Coolant control valves are designed to open at 60°F., 65°F., or 125°F., depending on the vehicle manufacturer.) The vacuum gauge should now indicate the presence of vacuum (carburetor vacuum). If it does not, replace the coolant control valve.

Figure 37-15 Checking Movement of EGR Valve Stem



Adapted from *1975 Emission Controls*. Chrysler Motors Corporation.

EGR Valve Test

STEP 7 Allow the engine to idle in neutral, with the engine warmed up to operating temperatures.

- While you accelerate the engine quickly to approximately 2000 RPM, look at the EGR valve stem to see if it moves (see figure 37-15).
- Repeat this procedure a few times to be sure that the EGR valve stem moves or does not move.

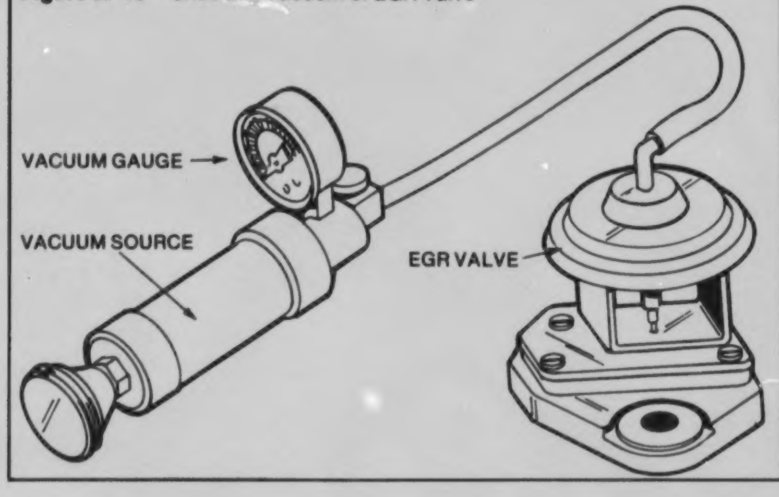
GOOD If the EGR valve stem moved during acceleration, it is operating properly.

BAD If there is no movement of the EGR valve stem, the EGR valve should be replaced or serviced, depending on the vehicle manufacturer's recommendations.

Some vehicle manufacturers recommend a different procedure for checking EGR valves, especially those installations in which the valve stem is not exposed and cannot be seen from outside the engine. For these installations:

- Look in your technical service manual for the EGR valve test procedures and specifications for the proper year, make, and model of the vehicle.
- Disconnect the vacuum hose from the EGR valve and connect an outside vacuum source to the valve (see figure 37-16). If you have an engine analyzer with a built-in vacuum source, you may use it in place of the portable unit shown.

Figure 37-16 Checking Vacuum of EGR Valve



110

- With the engine idling at normal operating temperatures, gradually apply vacuum to the EGR valve. If the EGR valve has an exposed valve stem, the stem should move.
- Apply 8-10 inches of vacuum (follow vehicle manufacturer's specifications).

GOOD Engine roughens, or engine RPM decreases or stops completely. Some specifications state that engine RPM should drop at least 150 RPM.

BAD If there is no change in the engine idle or the engine RPM drop is less than 150 RPM, there is a defective valve or a buildup of exhaust deposits in the valve or in the intake manifold EGR passages. The EGR valve should be replaced or serviced, depending on the vehicle manufacturer's recommendations.

Carburetor EGR Port Test

Use a vacuum gauge to check whether the EGR port at the carburetor (vacuum source) is plugged or restricted:

STEP 8 Disconnect the hose from the carburetor vacuum port and attach the vacuum gauge directly to the port fitting.

STEP 9 With the engine idling, open the throttle quickly to at least half-open throttle.

STEP 10 Look at the vacuum gauge for a quick rise and fall in the reading as the throttle is opened and closed.

GOOD If vacuum is present, the EGR port at the carburetor is open.

BAD If no vacuum is present, the EGR port is plugged or restricted and should be cleaned. Do not use a drill or wire. The carburetor should be cleaned with carburetor cleaner solvent.

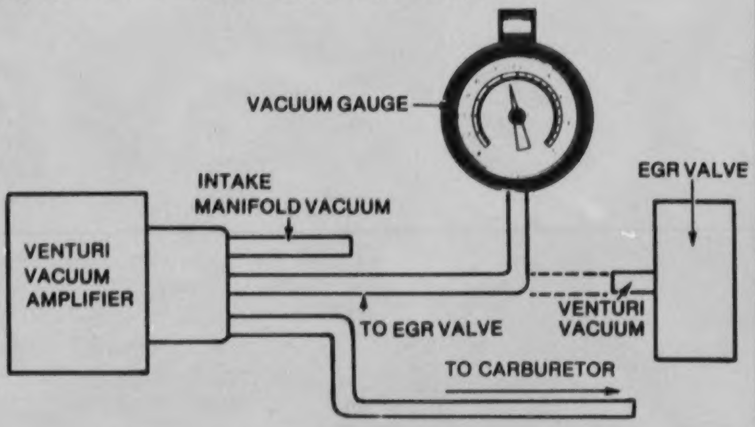
Venturi Vacuum Amplifier Test

Amplifiers have built-in calibrations, so no external adjustments are required. If an amplifier test reveals a malfunction, replace the amplifier.

STEP 11 Look in your technical service manual for the venturi vacuum amplifier-system test procedures and specifications for the year, make, and model of the vehicle.

STEP 12 Operate the engine at idle and at normal operating temperatures. Remove the vacuum hose at the EGR valve and connect the vacuum gauge to the EGR hose (see figure 37-17).

Figure 37-17 Checking the Venturi Vacuum Amplifier



STEP 13 Remove the vacuum hose from the carburetor venturi and leave it disconnected. If the amplifier has 0 inches of vacuum bias (a manufacturer's calibration), the vacuum reading should be 0-.5 inches. If the amplifier has a bias calibration other than 0 inches, the reading should be 0 ± .3 inches of the vehicle manufacturer's bias specifications.

GOOD If the vacuum readings are within the tolerances specified above, the amplifier is okay.

BAD If the vacuum readings are not within the tolerance specified, the amplifier should be replaced.

STEP 14 Accelerate the engine to 1500-2000 RPM and release the throttle. After the engine has returned to idle, the vacuum should return to the proper bias values given in step 13.

- If the vacuum gauge reading has changed from the specified values, the amplifier should be replaced. Even if the vacuum reading increases during acceleration, the amplifier should be replaced.

STEP 15 Reconnect the venturi hose to the carburetor. If this causes an increase in the vacuum reading of more than .5 inches above the values specified in step 13, check the idle speed.

STEP 16 Disconnect the vacuum hose that extends from the amplifier to the intake manifold, and plug the amplifier port. Accelerate the engine quickly to 1500-2000 RPM.

GOOD If the vacuum increases to 4 inches or more, the amplifier is okay.

BAD If there is no increase or not enough increase in vacuum, replace the vacuum amplifier.

This concludes the basic procedures for inspection and testing of an exhaust gas recirculation system. The basic components that YOU should now be able to inspect and test are: floor jets, EGR system hoses and connections, coolant control valves, EGR valves, carburetor EGR ports, and venturi vacuum amplifiers.

Other EGR Systems Vacuum Control Devices

Some vehicle manufacturers include other vacuum control devices in their engineering efforts in an attempt to maintain a careful balance of economy, engine performance and, of course, low NOx emissions.

Always refer to the technical service manual for the particular vehicle when you inspect and test its exhaust gas recirculation system. The technical service manual provides you with the specific procedures and specifications.

Chrysler vehicles. All Chrysler vehicles use a coolant control valve that is installed in the radiator top tank. However, before March 15, 1973, a temperature control valve (engine compartment temperature) was used. In addition, both the carburetor port vacuum and the venturi vacuum and vacuum amplifier EGR systems are currently in use (see figure 37-18).

Some Chrysler venturi vacuum-controlled systems have a time delay solenoid that cuts off vacuum to the EGR valve for 35 seconds after the ignition switch is turned on (see figure 37-19).

Since 1975, Chrysler has installed an EGR maintenance reminder system that signals the vehicle owner at 15,000-mile intervals that the EGR system requires service. You will learn how to service this system in the section on servicing EGR systems later in this performance objective.

Ford vehicles. Among Ford vehicle models, you will find EGR systems that use either intake manifold-mounted

Figure 37-18 Chrysler Temperature Control Valve Prior to March 15, 1973

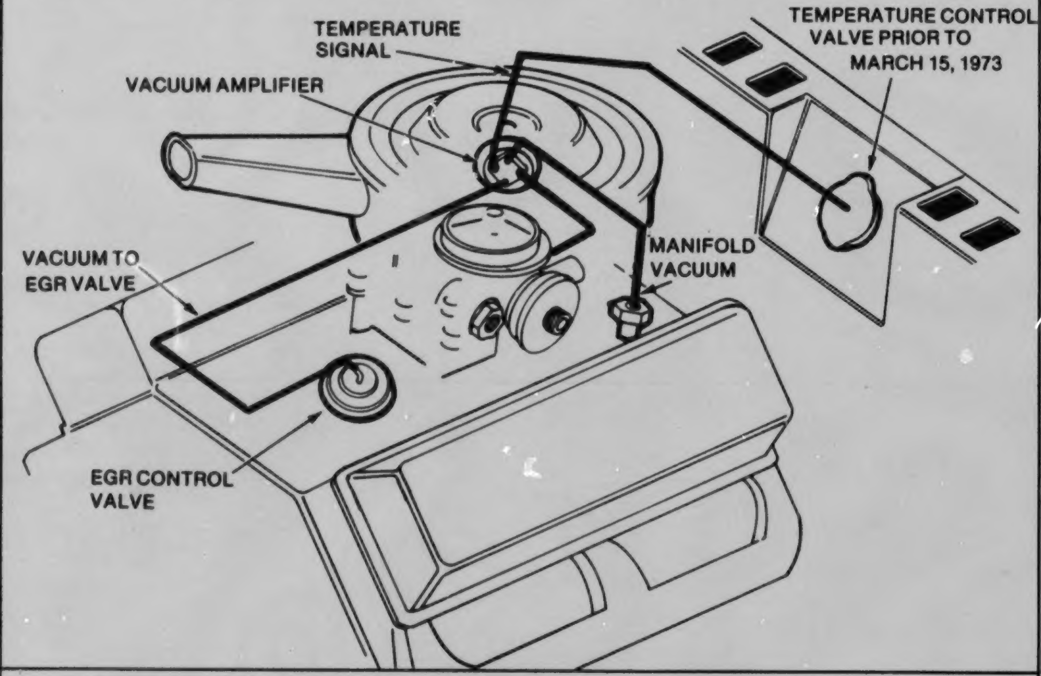
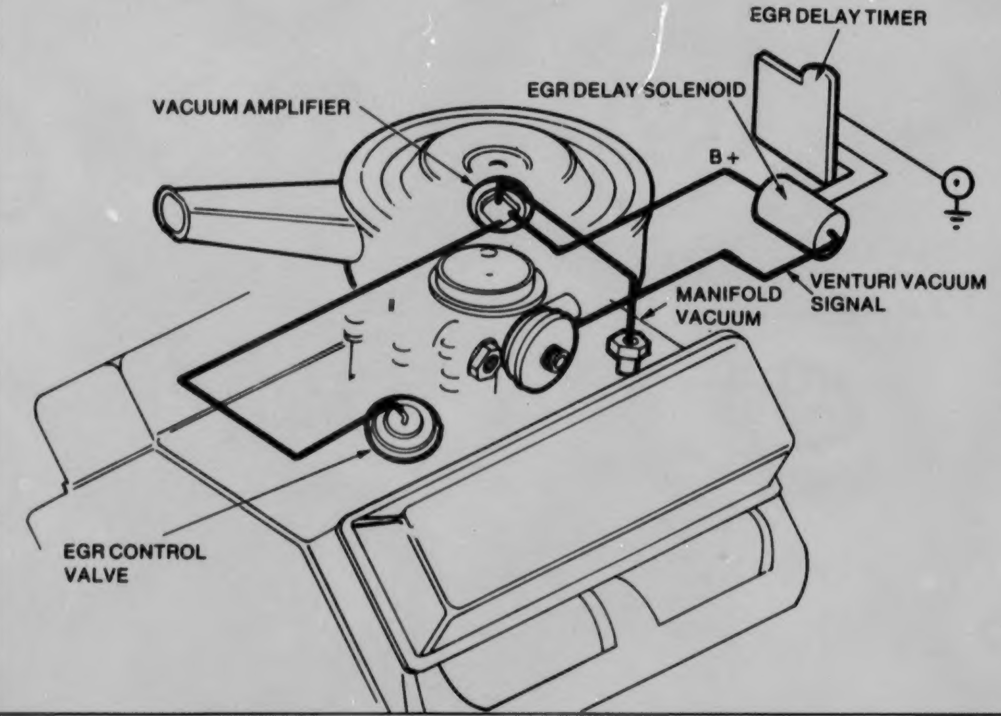

TEMPERATURE SIGNAL
VACUUM AMPLIFIER
TEMPERATURE CONTROL VALVE PRIOR TO MARCH 15, 1973
VACUUM TO EGR VALVE
MANIFOLD VACUUM
EGR CONTROL VALVE

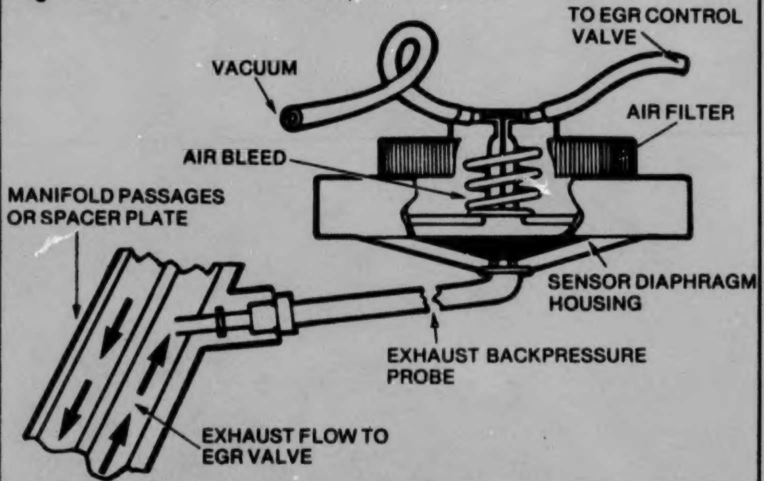
Figure 37-19 Chrysler System with EGR Delay Timer


EGR DELAY TIMER
EGR DELAY SOLENOID
VACUUM AMPLIFIER
B+
VENTURI VACUUM SIGNAL
MANIFOLD VACUUM
EGR CONTROL VALVE

EGR valves or carburetor spacer-mounted EGR valves. You'll also find either carburetor port vacuum control systems or venturi and amplifier-vacuum control systems. Some Ford-built engines use a speed-controlled solenoid valve to cut off the EGR vacuum signal at high speeds.

American Motors vehicles. Some 1974 American Motors vehicles have EGR systems that use an ***exhaust backpressure sensor*** (see figure 37-20).

Figure 37-20 AMC Exhaust Backpressure Sensor


TO EGR CONTROL VALVE
VACUUM
AIR FILTER
AIR BLEED
MANIFOLD PASSAGES OR SPACER PLATE
SENSOR DIAPHRAGM HOUSING
EXHAUST BACKPRESSURE PROBE
EXHAUST FLOW TO EGR VALVE

The exhaust backpressure sensor consists of a small metal tube projecting into an exhaust gas passage in the intake manifold. The other end of the tube projects into the sensor diaphragm housing. Its purpose is to ensure the maximum EGR during acceleration when backpressure is high. The high backpressure operates the diaphragm and closes an air bleed in the EGR valve vacuum line (see figure 37-20).

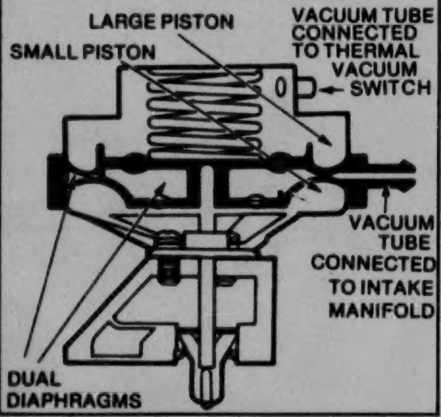
Some 1974 Pontiacs and Oldsmobiles also use an exhaust backpressure sensor.

General Motors Vehicles. General Motors vehicles use a carburetor-ported vacuum-controlled system that causes the EGR valves to open in the 30-70 mph-range.

Some 1974 Chevrolet and Pontiac engines use a dual-diaphragm EGR valve to provide better EGR balance during cruising (see figure 37-21).

Turn to your Review Exercise Book and complete Exercise 11.

Figure 37-21 General Motors Dual Diaphragm EGR Valve


LARGE PISTON
SMALL PISTON
VACUUM TUBE CONNECTED TO THERMAL VACUUM SWITCH
VACUUM TUBE CONNECTED TO INTAKE MANIFOLD
DUAL DIAPHRAGMS

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin any of these work activities until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

2. Inspect and test the operation of a port vacuum-controlled exhaust gas recirculation system. Write down the defects you find (pages 106-10).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

3. Inspect and test the operation of a venturi vacuum-controlled exhaust gas recirculation system. Write down the defects you find (pages 110-11).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

After you have finished these activities, go on to the next section.

Servicing the Exhaust Gas Recirculation System

Floor jets

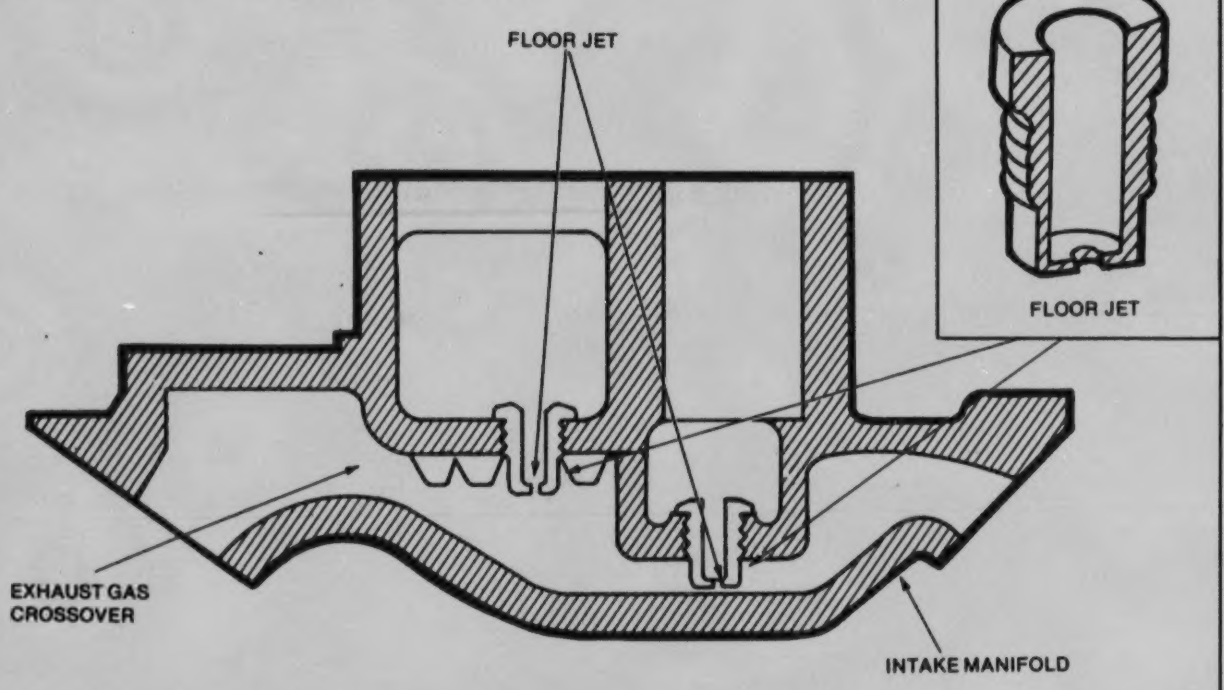
The floor jets of the Chrysler EGR system should be inspected and, if necessary, cleaned every 12,000 miles following the first inspection at 24,000 miles.

To clean the jets when they become plugged:

STEP 1 Remove the carburetor air cleaner and the carburetor from the vehicle. (If you need to review the removal and installation procedures, refer to Performance Objective 30 in Unit 5.)

STEP 2 Using a socket wrench, remove the jets from the manifold floor (see figure 37-22).

Figure 37-22 Cross Section of Chrysler Floor Jet System



CAUTION: The floor jets are made of antimagnetic, stainless steel materials. Do not drop the jets into any of the intake manifold ports because it is difficult to pick them out. A magnet won't work and you may have to remove the intake manifold to retrieve the jets.

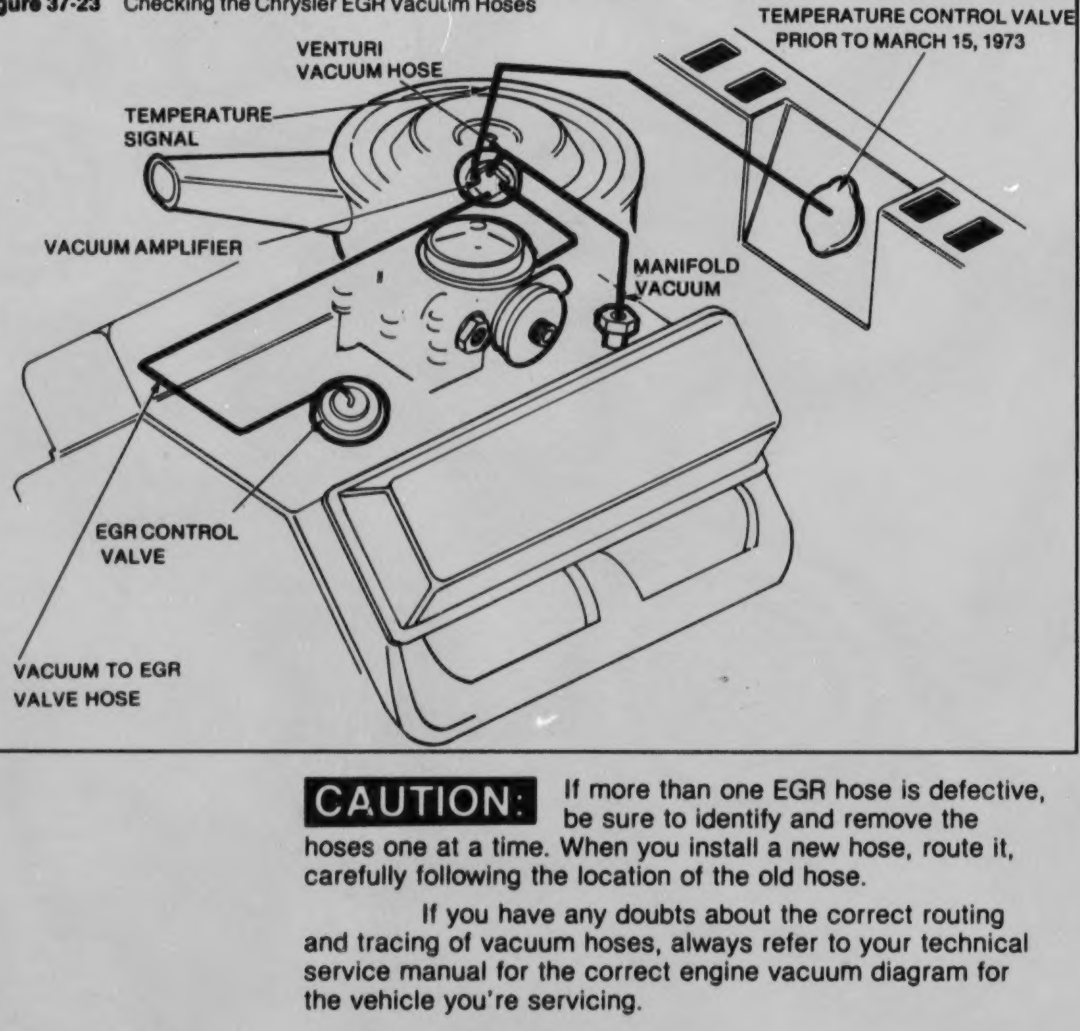
STEP 3 Clean the jets in carburetor cleaning solvent until the orifices or passageways are open. Do not use a drill or wire to unplug and clean the orifices.

STEP 4 Reinstall the jets and torque them to 25 ft-lbs. Reinstall the carburetor and the air cleaner.

Vacuum Hoses

A vacuum hose that is cracked, hardened, or leaking is easily replaced by simply disconnecting each end of the vacuum hose from each EGR component and removing the hose (see figure 37-23).

Figure 37-23 Checking the Chrysler EGR Vacuum Hoses


TEMPERATURE CONTROL VALVE
PRIOR TO MARCH 15, 1973
VENTURI
VACUUM HOSE
TEMPERATURE
SIGNAL
VACUUM AMPLIFIER
MANIFOLD
VACUUM
EGR CONTROL
VALVE
VACUUM TO EGR
VALVE HOSE

CAUTION: If more than one EGR hose is defective, be sure to identify and remove the hoses one at a time. When you install a new hose, route it, carefully following the location of the old hose.

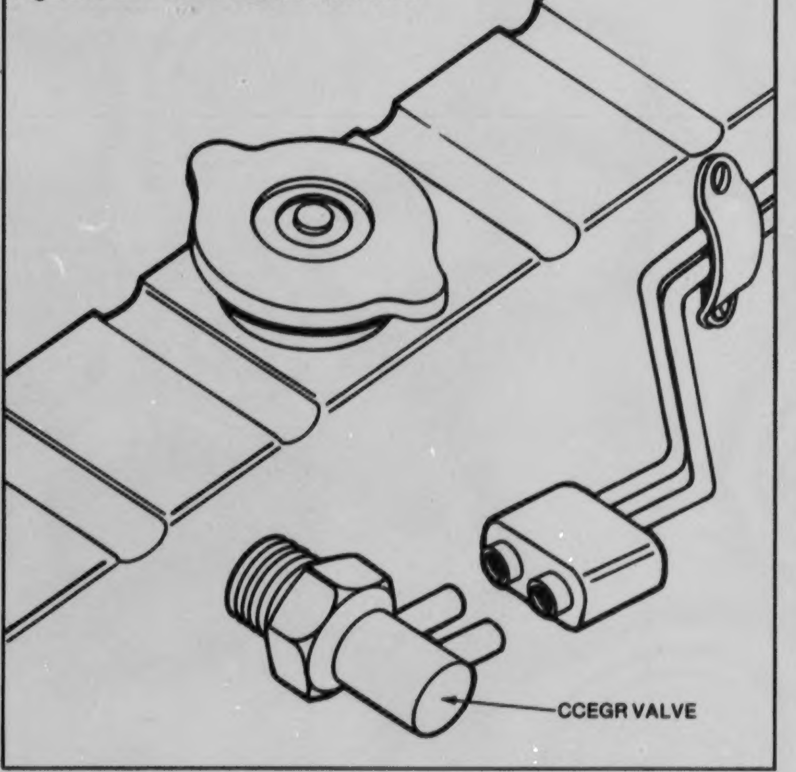
If you have any doubts about the correct routing and tracing of vacuum hoses, always refer to your technical service manual for the correct engine vacuum diagram for the vehicle you're servicing.

After you have completed installing any hose, do an operational check of the EGR system to see that it is performing correctly.

EGR Coolant Control Valve

If a coolant control valve is defective, it must be replaced. To replace the valve:

Figure 37-24 EGR Coolant Control Valve



STEP 1 Drain the coolant from the radiator into a clean container.

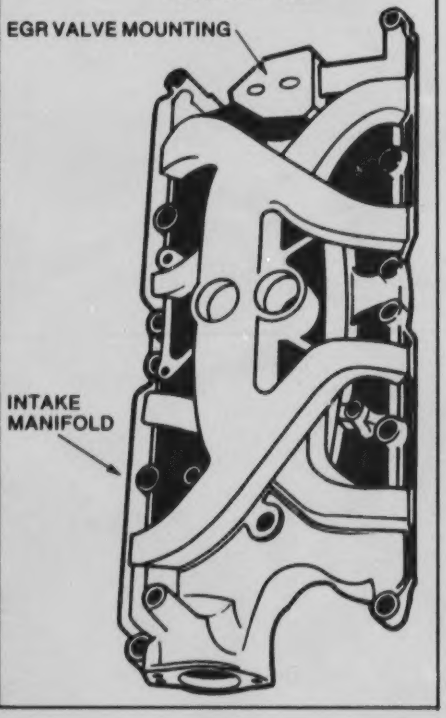
STEP 2 Disconnect the EGR hose connector from the valve (see figure 37-24).

STEP 3 Using the proper sized wrench, remove the valve from the radiator top tank. Then install the new valve.

NOTE: When you give the coolant control valve its final tightening, be sure the vacuum ports are pointed in the direction of the hoses and hose connector routing. Reconnect the hose connector.

STEP 4 Reinstall the coolant in the radiator.

Figure 37-25 EGR Valve Mounting on Intake Manifold



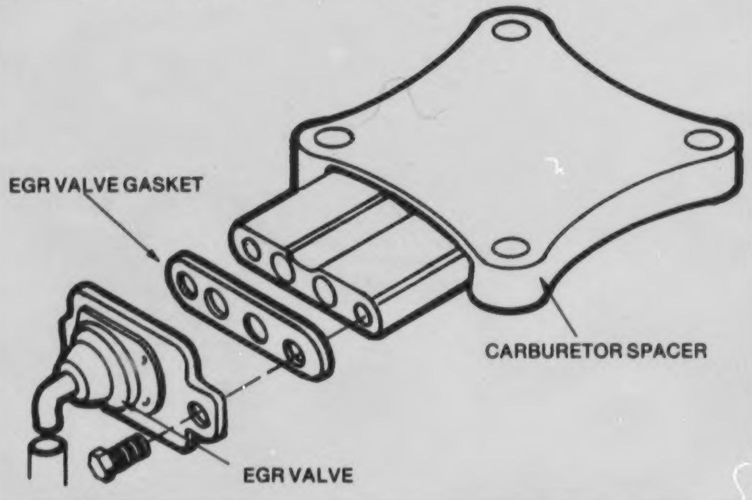
STEP 5 Do an operational check of the coolant control valve after you install it. Make sure that the radiator coolant is not leaking from around the threads of the valve.

EGR Valve

If the EGR valve is not operating properly or is defective, it should be either replaced or cleaned. For specific instructions, refer to the vehicle manufacturer's recommendations in the technical service manual for the vehicle being serviced. The steps below are general instructions.

STEP 1 Remove the EGR valve, gasket, and clamp, if present, from their mountings either on the intake manifold (see figure 37-25) or on the carburetor spacer (see figure 37-26).

Figure 37-26 Removing EGR Valve from Carburetor Spacer



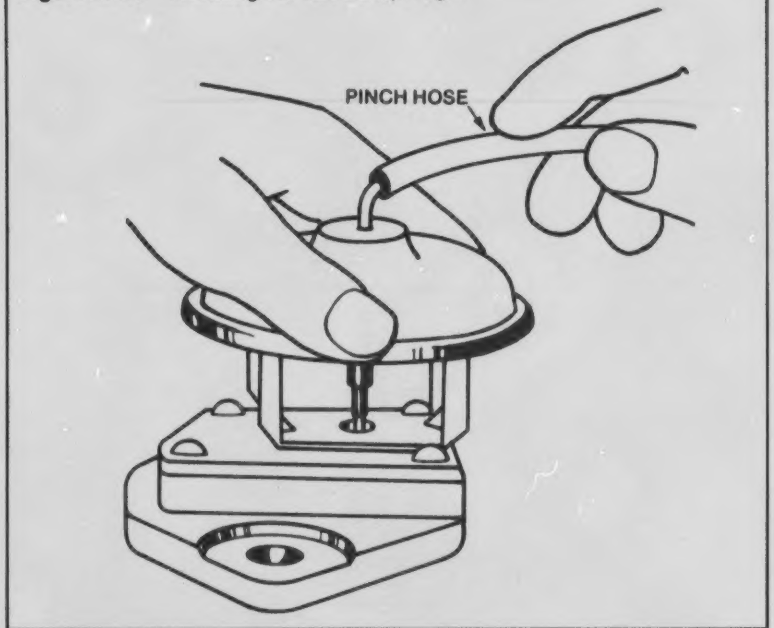
STEP 2 Inspect the valve for deposits, paying particular attention to the valve poppet and seat area. If there is more than a thin film of deposit buildup, the valve should be cleaned.

STEP 3 Check the condition of the valve diaphragm. Depress the diaphragm and plug the vacuum tube inlet (see figure 37-27). Release the diaphragm.

- If the valve has *not* closed in 20 seconds, the EGR valve is okay.
- If the valve closes within 20 seconds,

replace the valve. The valve diaphragm is defective.

Figure 37-27 Checking the Valve Diaphragm



CAUTION: Some manufacturers require that you operate the valve by using a vacuum source, not by pushing on the diaphragm. Check in your technical service manual for proper directions.

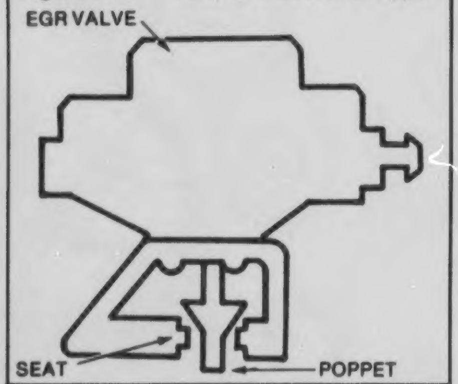
STEP 4 Clean the EGR valve seat area with manifold heat control solvent. Allow half an hour for the deposits to soften. Then, using a sharp tool, scrape all the deposit from the poppet and seat (see figure 37-28).

CAUTION: Do not allow the solvent to get on the diaphragm, since it may damage the diaphragm, causing it to fail.

NOTE: A standard spark plug cleaner can be used to clean the diaphragm. First blast the valve and seat area for 30 seconds only. Then depress the diaphragm and blast again for 30 seconds. Be sure to blow all abrasive materials out of the valve with compressed air.

STEP 5 Scrape the old gasket material from the EGR valve mounting base and, with a new gasket, install the EGR valve.

Figure 37-28 EGR Valve Seat and Poppet

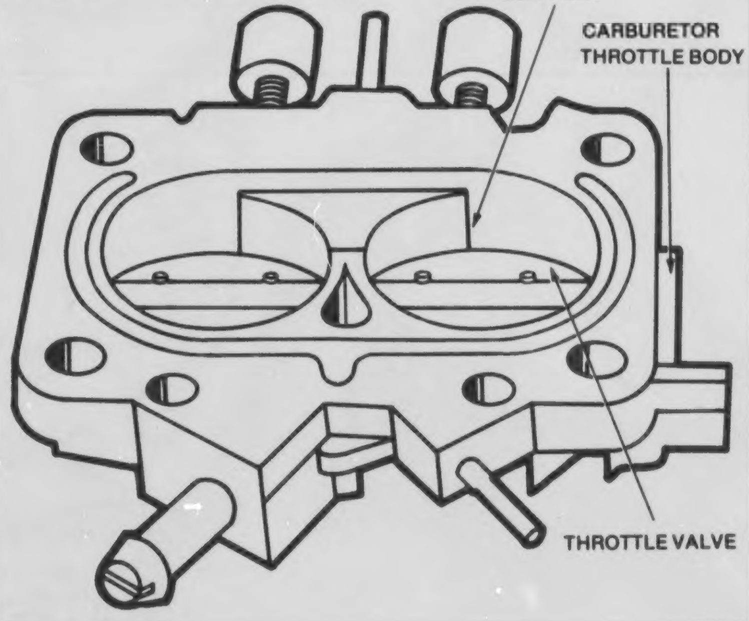


NOTE: EGR valves cannot be interchanged. When you replace these valves, be sure you have the correct valve for the vehicle engine you're servicing.

Carburetor Vacuum Ports

If the carburetor vacuum ports are plugged with deposits, remove and disassemble the carburetor, and clean it and the vacuum ports with carburetor cleaner solvent (see figure 37-29).

Figure 37-29 Carburetor Vacuum Ports


EGR PORT
CARBURETOR THROTTLE BODY
THROTTLE VALVE

CAUTION: Do not use a drill or wire to unplug and clean the carburetor vacuum ports. To do so might damage or enlarge the port, changing its calibration.

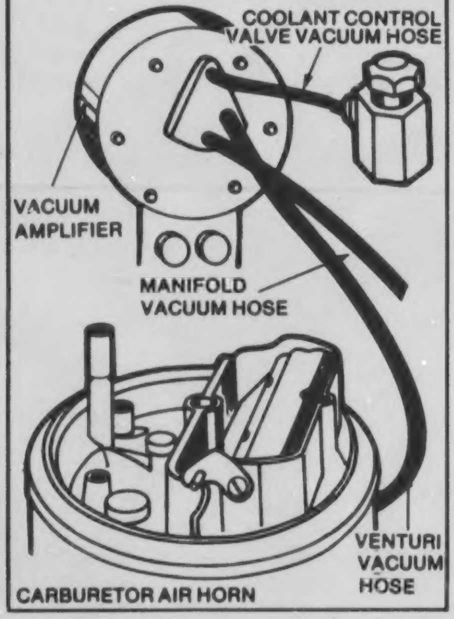
Venturi Vacuum Amplifier

Replace the venturi vacuum amplifier when it is defective.

STEP 1 Disconnect and mark each vacuum hose that is attached to the amplifier. Mark each vacuum port to which the hoses are attached on the amplifier (see figure 37-30).

STEP 2 Remove the amplifier from its mounting. Install the new amplifier and reconnect the vacuum hoses to the correct vacuum ports.

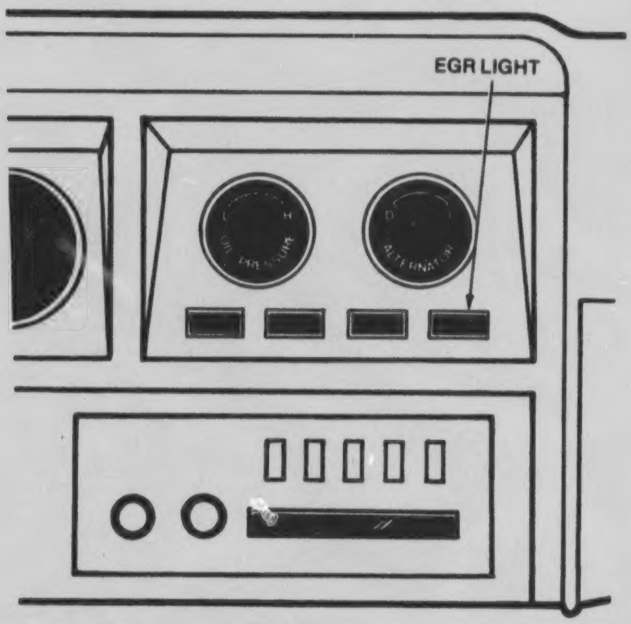
Figure 37-30 Venturi-Vacuum Amplifier and Connecting Hoses


COOLANT CONTROL VALVE VACUUM HOSE
VACUUM AMPLIFIER
MANIFOLD VACUUM HOSE
VENTURI VACUUM HOSE
CARBURETOR AIR HORN

EGR Maintenance Reminder System

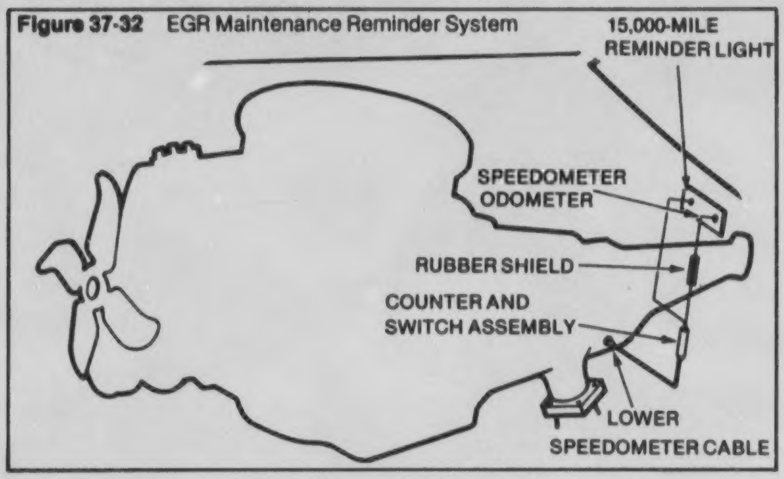
The Chrysler EGR maintenance reminder system is a counting device that alerts the driver at 15,000-mile intervals to have the EGR system inspected. An instrument dash light glows when the vehicle has traveled 15,000 miles, and recurs each 15,000 miles thereafter (see figure 37-31).

Figure 37-31 EGR Light on Dashboard


EGR LIGHT
OIL PRESSURE
ALTERNATOR

The system consists of a counter and switch assembly mechanism inserted in series in the speedometer cable (see figure 37-32).

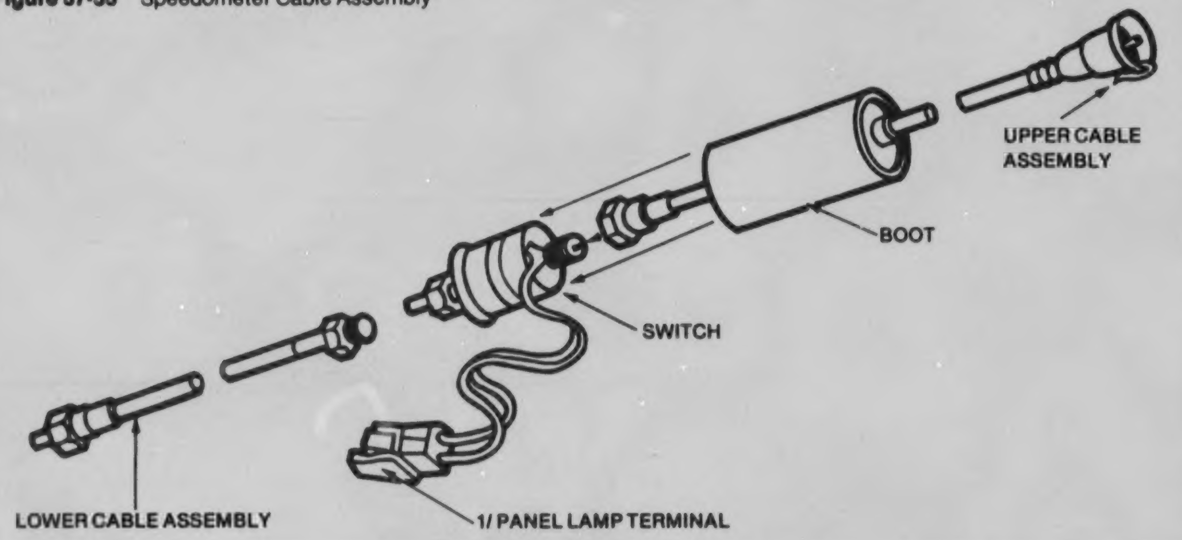
Figure 37-32 EGR Maintenance Reminder System


15,000-MILE REMINDER LIGHT
SPEEDOMETER ODOMETER
RUBBER SHIELD
COUNTER AND SWITCH ASSEMBLY
LOWER SPEEDOMETER CABLE

EGR reminder light. This indicator is located on the instrument dash cluster, and lights up every 15,000 miles.

Counter and switch assembly. The assembly contains gears and a set of electrical contacts (see figure 37-33). At 15,000-mile intervals, the circuit closes, causing the reminder light to light.

Figure 37-33 Speedometer Cable Assembly



Upper and lower speedometer cables.

To reset the switch following the EGR system inspection:

STEP 1 Slip the rubber boot or shield up on the upper speedometer cable to expose the reset screw (see figure 37-33).

NOTE: It may be necessary to disconnect one of the speedometer cables in order to have access to the reset screw.

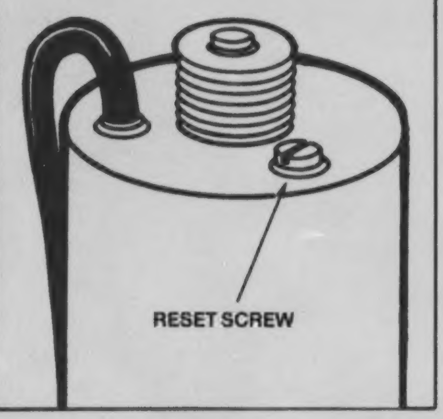
STEP 2 Turn the reset screw about a half turn and release it (see figure 37-34). This zeros the odometer gears and opens the electrical circuit.

STEP 3 Reconnect the speedometer cable, if necessary. Reconnect the boot.

The EGR reminder system is now ready to count the next 15,000-mile interval.

Turn to your Review Exercise Book and complete Exercise 12.

Figure 37-34 Reset Screw for EGR Reminder Light



124

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin any of the work activities until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

4. Remove, clean, test, and install an EGR valve from a vehicle engine (pages 119-21).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

5. Locate an EGR maintenance reminder system on a 1975 Chrysler-made engine and locate the reset screw on the counter and switch assembly. Reset the switch, if necessary (pages 122-23).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

When you have finished this activity, ask your instructor to return your pretest on Performance Objective 37. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 38

INSPECT, TEST, AND SERVICE IGNITION TIMING CONTROL SYSTEMS

INTRODUCTION

During the remainder of this Student Guide you will analyze and test ignition timing control systems. These systems control the distributor spark timing, advancing or retarding it according to the throttle opening, vehicle speed, transmission gears, and temperature. There are several types of ignition timing controls, but each is used to extend timing and improve combustion, and at the same time providing good engine performance and fuel economy.

Control of ignition timing involves five areas of engine operation: idle, low speed, high speed, acceleration, and deceleration. The methods used by each vehicle manufacturer to advance or retard ignition timing to achieve better combustion and lower emission levels during each of the areas of engine operation will be covered in the sections on each ignition timing control. You should be aware that when you are troubleshooting an engine that runs roughly, has spark knocks or pings, and shows an increase in fuel consumption, you must test the ignition timing controls in addition to performing the conventional tune-up procedures.

Throughout this Student Guide you have been directed to refer to your technical service manual whenever you service an exhaust emission system or the control device for a particular vehicle. As manufacturers change or improve the systems, the only way to ensure that you are using accurate information and keep up-to-date is to use the manual.

Performance Objective 38, ***Inspect, Test and Service Ignition Timing Control Systems,*** has six checklists. Six checklists are necessary because there are six major types of ignition timing control systems. After you finish the work activities for each of these systems, your instructor will use a checklist like the one below to evaluate your work. The other five checklists are on testing and servicing: (1) the electronic spark control system; (2) Ford's TAV system; (3) Ford's CTAV system; (4) Chrysler's OSAC system; and (5) Chrysler's TIC valve.

PERFORMANCE CHECKLIST—P.O. 38

The instructor will provide a vehicle that has a TCS system. Test the system and correct any problems you find. All of the performances below must be accomplished.

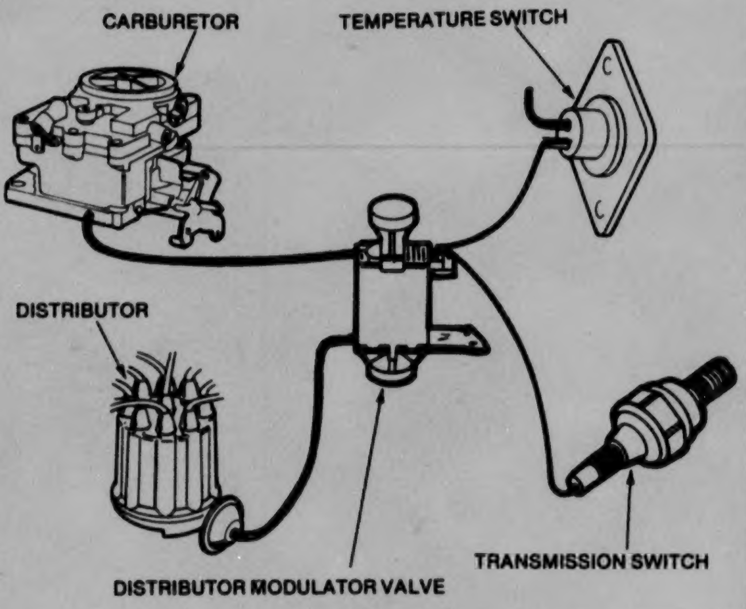
Student Performance	**Instructor Ratings**		
	Acceptable	Not Acceptable	Omit
1. Checks and adjusts engine initial timing.			
2. Tests distributor spark advance and compares readings with manufacturer's specifications.			
3. Tests distributor spark retard (dual diaphragm vacuum unit) and compares readings with manufacturer's specification.			
4. Tests distributor retard solenoid operation.			
5. Tests the operation of a transmission regulated spark system on a Ford vehicle.			
6. Raises the rear of the vehicle from the floor and supports it.			
7. Tests each transmission control spark system component (transmission switch and temperature switch of a Ford TRS system).			
8. Corrects any problems found.			
9. Uses vacuum-pressure gauge.			
10. Lowers vehicle safely to the floor.			
11. Follows all appropriate safety precautions.			
12. Time.			

SAMPLE

Transmission Controlled Spark (TCS) System

The purpose of the transmission controlled spark (TCS) system is to use the advantages of retarded timing to reduce exhaust emissions by eliminating distributor vacuum advance in all gears except high gear. To do this, the TCS system regulates the amount of distributor vacuum advance signal sent to the distributor during different transmission gear ranges.

Figure 38-1 Ford Transmission Regulated Spark Control (TCS) System



Ford's transmission regulated spark control system (see figure 38-1) is used on 1972 and 1973 vehicles. Chrysler's NOx transmission control system, is used on 1971 and 1972 vehicles. General Motors' TCS system was introduced on their 1970 vehicles, and American Motors' system, which is similar, was introduced in 1971.

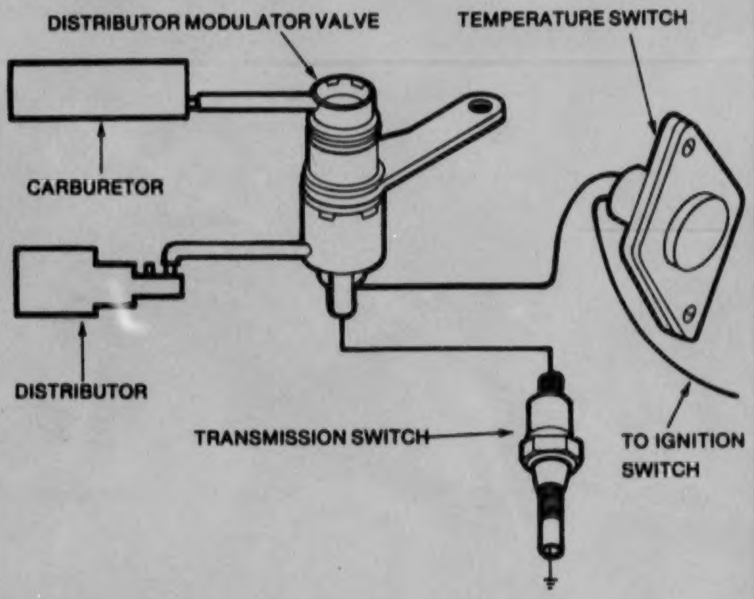
Components of the Ford Transmission Regulated Spark (TRS) System

The Ford TRS system consists of two main components that control a distributor modulator valve that, in turn, regulates the manifold vacuum to the distributor vacuum advance unit. The system retards distributor vacuum advance in first and second gears. The system consists of:

Distributor modulator valve. An electric solenoid that, when de-energized (not activated), allows the vacuum supply to reach the distributor vacuum advance unit. When it is energized (activated), the vacuum supply is shut off and the distributor vacuum advance will not advance ignition timing.

- The distributor modulator valve is located in the vacuum line between the carburetor and the distributor. It is sometimes called a ***vacuum advance solenoid valve*** or ***solenoid vacuum valve***, and is considered to be the heart of the transmission controlled spark system.

Figure 38-2 Ford TRS System



Ambient temperature switch. (see figure 38-2). Located in either the left-hand or right-hand doorpost, the temperature switch senses outside air temperature. Temperatures below 49°F. cause the switch to open and allow normal vacuum advance in all gears. (The distributor modulator valve remains de-energized.) A temperature of 65°F. closes the switch and energizes the modulator valve, shutting off all vacuum to the distributor vacuum advance unit.

Transmission switch. When the transmission is shifted into high gear (manual) or into high range or reverse gear (automatic), the transmission switch opens, de-energizing the modulator valve. Vacuum is allowed to reach the distributor vacuum advance unit and restore normal vacuum advance.

- The switch for manual transmissions is mounted on the left side on the transmission case. When the gear lever is moved to high gear position, the lever contacts the switch and opens the circuit. For automatic transmissions, the switch is operated by fluid pressure in high range or in reverse gear.

On some installations, a ported vacuum switch (PVS) is mounted in the engine coolant jacket and serves as a temperature override switch. This switch operates in the same way as the coolant temperature override (CTO) switch, which allows the advance to increase when the coolant temperatures reach approximately 226°F. The speedup in engine idle that results allows the engine temperature to return to normal, preventing the engine from overheating.

Summary of the Ford TRS System Operation

Temperature Sw.	Transmission Sw.	Dist. Modulator Valve	Dist. Vacuum
	Engine Off		
open (49°F)		de-energized	advance
	Engine On (Cold Engine)		
open (49°F)	closed	de-energized	advance
	Low Gear Operation		
closed (65°F)	closed	energized	retarded
	High Gear Operation		
closed (65°F)	open	de-energized	advance

Turn to your Review Exercise Book and complete Exercise 13.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to the work activity. Do not begin the work activity until you have your instructor's approval. If you're not sure that you can do the work activity, ask your instructor for help.

1. Look at several Ford vehicles and identify the transmission regulated spark systems of each and the main parts of each system (pages 129-31).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

After you have finished this activity, go on to the next section.

Preliminary Tests of the Transmission Controlled Spark (TCS) System

Whenever you suspect a malfunction in a transmission controlled spark (TCS) system because of timing or timing advance problems, first check the engine's initial timing setting, timing advance, and retard mechanisms. You might be able to correct a suspected problem with the TCS system by eliminating a malfunction in these timing systems.

In addition to the engine timing tests and corrections, you should test the operation of the TCS system when the engine runs roughly, has spark knocks (pings), and shows an increase in fuel consumption.

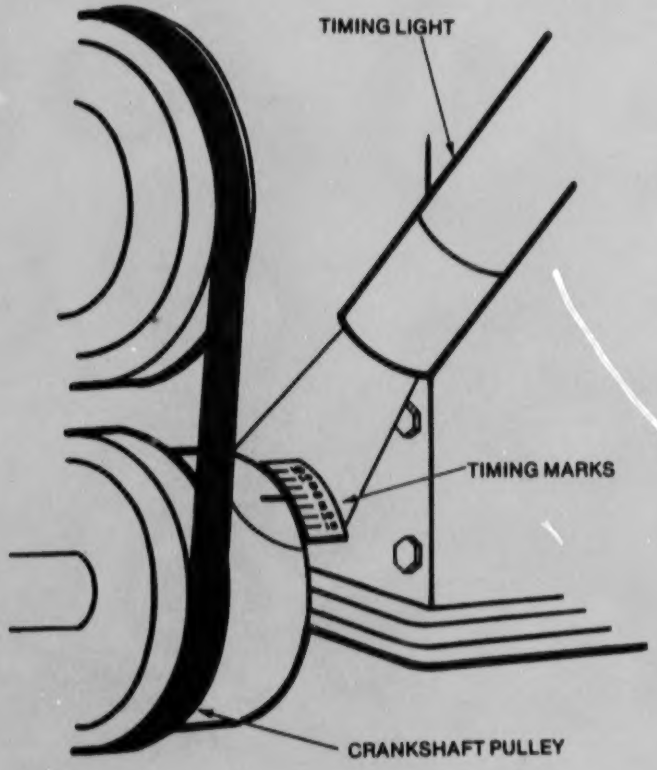
Initial timing.

STEP 1 Connect the timing light and the dwell tachometer to the engine.

STEP 2 With the engine at operating temperature and at the correct idle settings, test the distributor contact point dwell and, if necessary, correct it to the manufacturer's specifications.

STEP 3 Set the ignition timing to the manufacturer's specifications (see figure 38-3).

Figure 38-3 Setting the Timing



STEP 4 After you have set the ignition timing, reconnect the vacuum hoses to their proper connectors. If necessary, reset the idle speed to the specified RPM.

Spark advance tests.

STEP 1 Accelerate the engine to 2000 RPM.

STEP 2 Adjust the timing light control until the timing marks are aligned with the initial timing setting.

STEP 3 Read the timing light meter for degrees of total spark timing advance and compare the reading to the vehicle manufacturer's test specifications.

- If the readings indicated conform to the vehicle manufacturer's specifications, no further testing is required. Both mechanical and vacuum mechanisms are functioning properly.
- If the readings indicated do not conform to the vehicle manufacturer's specifications, proceed with the mechanical advance test to find out whether the mechanical or the vacuum advance mechanism is at fault. To do this, disconnect the vacuum hose(s), plug them, and repeat the test. (This tests the accuracy of the mechanical advance mechanism.)

If the timing advance is still incorrect, the distributor must be removed from the engine for repair or replacement.

Spark retard test.

STEP 1 Leave the vacuum hoses disconnected. If the distributor being tested is equipped with a dual diaphragm vacuum unit, you'll need to test the degrees of vacuum retard (see figure 38-4).

Figure 38-4 Vacuum Hoses Disconnected for Spark Retard Test

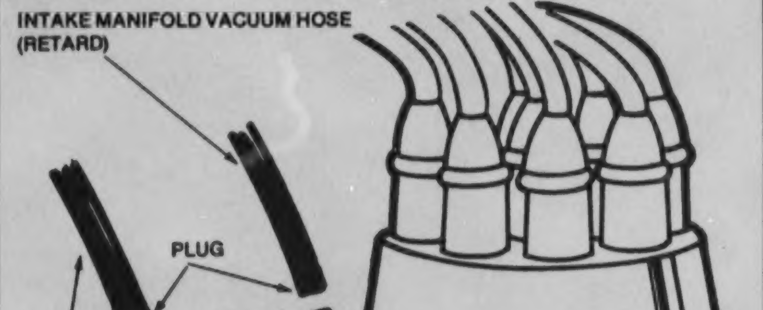
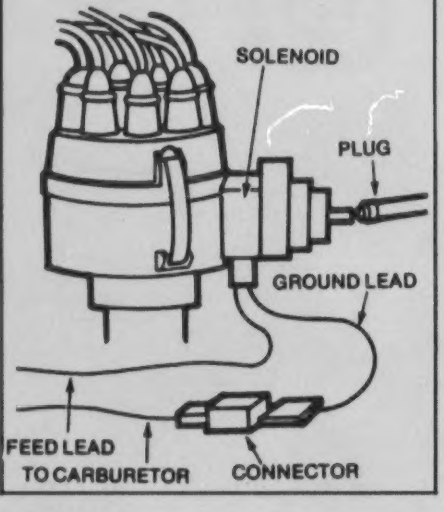

INTAKE MANIFOLD VACUUM HOSE (RETARD)
PLUG
CARBURETOR VACUUM HOSE (ADVANCE)

Figure 38-5 Testing the Distributor Retard Solenoid



STEP 2 With the engine idling, look at the timing marks. At the same time, connect the intake manifold hose to the inner vacuum chamber (retard).

- The timing should immediately retard the number of degrees listed in the specifications.

STEP 3 Replace the vacuum unit if the degrees of retard do not conform to the degrees of retard specified by the vehicle manufacturer.

STEP 4 Unplug and reconnect the vacuum hoses.

Distributor retard solenoid test. If the vehicle has a distributor retard solenoid, you'll need to test its operation (see figure 38-5).

STEP 1 Disconnect and plug the distributor vacuum hose (see figure 38-5).

STEP 2 With the engine idling, look at the timing marks. At the same time, disconnect the distributor ground lead connector near the carburetor. Watch the timing marks; timing should advance at least 5 degrees from the initial timing setting, and the engine speed should increase.

STEP 3 While you watch the timing marks, reconnect the distributor ground lead connector.

- Timing should retard to the initial timing setting and the engine speed should return to its specified idle setting.

STEP 4 Repeat this test a few times and watch for timing mark movements to be sure the solenoid operates freely.

STEP 5 Replace the distributor vacuum and solenoid unit assembly if the unit does not operate as specified.

STEP 6 Unplug and reconnect the vacuum hose. Disconnect the timing light.

Any initial, advance, or retard timing malfunctions should be corrected before you proceed to any transmission controlled spark system test.

Turn to your Review Exercise Book and complete Exercise 14.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin any of the work activities until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

2. Test the initial timing setting, timing advance, and retard mechanisms on a Ford vehicle that has a TRS system. Look in your technical service manual for the vehicle's timing specifications and write them down (pages 132-36).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

3. Test the distributor timing retard for correct operation on a Chrysler Corporation vehicle that has a distributor retard solenoid (page 135).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

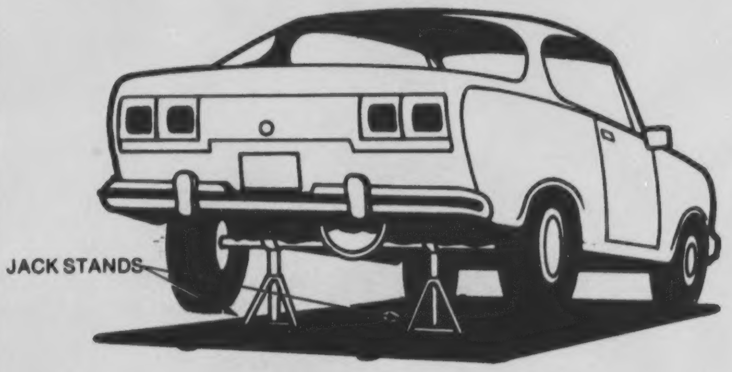
After you have finished these activities, go on to the next section.

Testing the Ford TRS System

To test the Ford TRS system, the engine must be at normal operating temperatures and the temperature at the temperature switch must be above 65°F.

STEP 1 Raise the rear wheels of the vehicle and support the vehicle with jack stands (see figure 38-6).

Figure 38-6 Proper Placement of Jack Stands



CAUTION: Before proceeding, be sure that the jack stands are positioned properly and will hold the vehicle safely.

STEP 2 Connect a vacuum gauge in the vacuum line between the distributor and the distributor modulator valve (see figure 38-7). Use a tee fitting to make the connection (see figure 38-8).

Figure 38-7 Testing the Ford TRS System

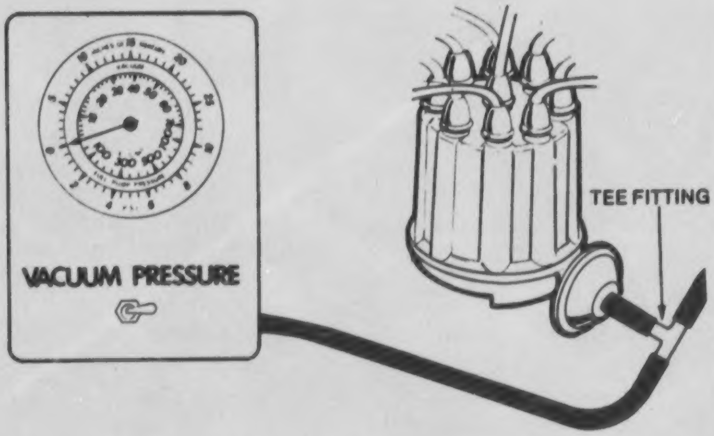
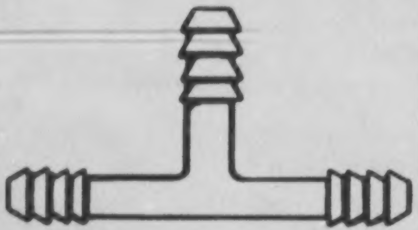


Figure 38-8 Tee Fitting

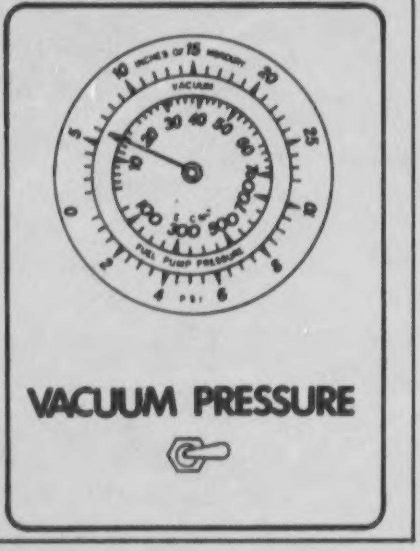


STEP 3 Position the vacuum gauge and the dwell/tachometer so that they can be seen from the driver's seat.

Manual transmission.

- Start the engine with the transmission in neutral. No vacuum (zero vacuum) should be indicated.
- Push down on the clutch pedal and increase the engine speed to 1000-1500 RPM. No vacuum (zero vacuum) should be indicated.
- Shift the transmission to high gear, and keep the clutch pedal down. With the engine operating at 1000-1500 RPM, the vacuum gauge should indicate at least 6 inches of vacuum (see figure 38-9).

Figure 38-9 Vacuum Gauge Reads 6 Inches of Vacuum



Automatic transmission.

- Start the engine with the transmission in Park or Neutral. No vacuum should be indicated.
- Shift into Reverse. At low RPM, the vacuum gauge may show a reading. (Remember, in reverse and in high range, vacuum is allowed to reach the distributor vacuum advance unit.) If no vacuum is indicated:
- Disconnect one wire from the distributor modulator valve. Shift into Neutral and increase the engine speed to 1000-1500 RPM. Vacuum should be indicated on the vacuum gauge. If no vacuum is indicated:
- Disconnect both vacuum hoses from the distributor modulator valve and connect them with a nipple.
- Increase the engine speed to 1000-1500 RPM. A vacuum reading indicates that the vacuum supply is operational to the distributor, bypassing the modulator valve.

Should the system fail to function during these tests, test each component individually until the fault is located.

Testing the Ford TRS Components

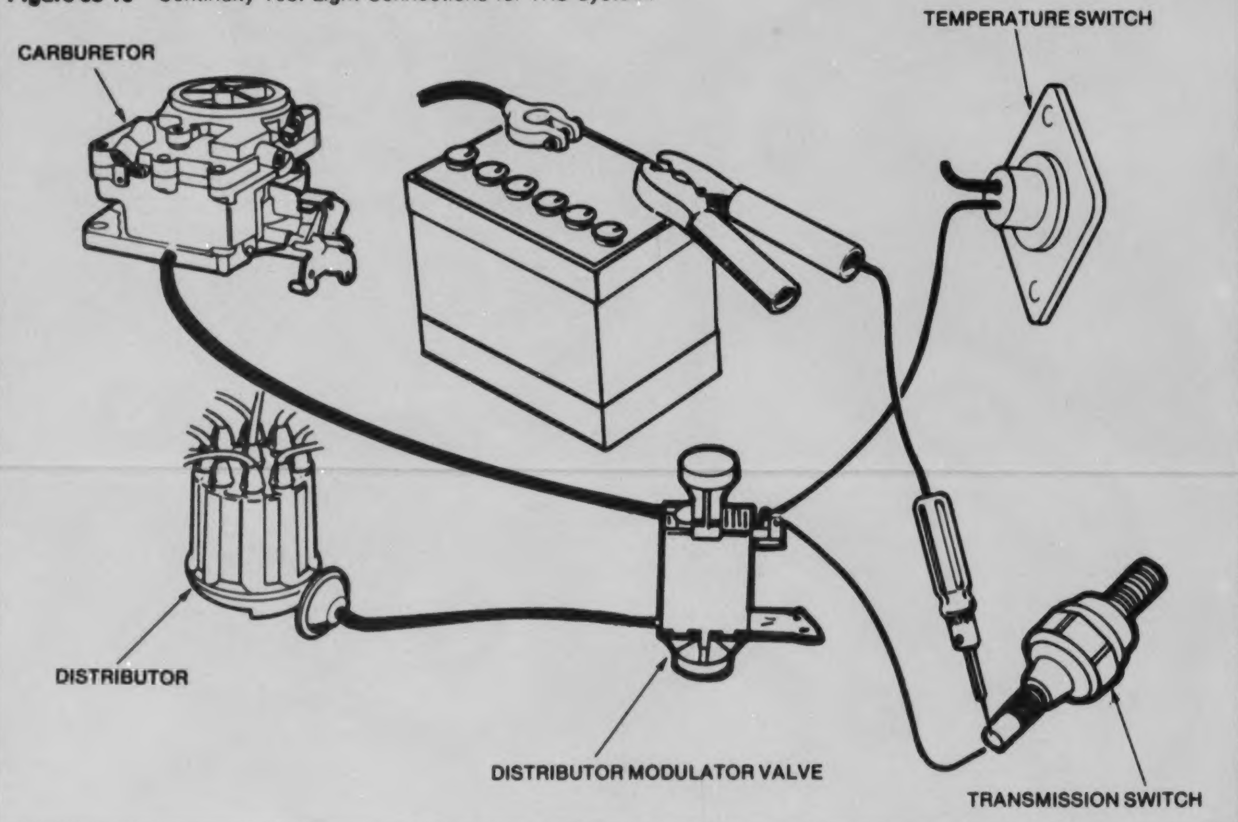
If the test of the TRS system operation indicates a malfunction, it is necessary to test each TRS component to locate the fault.

Transmission switch test.

STEP 1 Disconnect the transmission switch lead from the distributor modulator valve.

STEP 2 Connect a continuity test light to the transmission switch lead and to the battery positive terminal (see figure 38-10).

Figure 38-10 Continuity Test Light Connections for TRS System.


TEMPERATURE SWITCH
CARBURETOR
DISTRIBUTOR
DISTRIBUTOR MODULATOR VALVE
TRANSMISSION SWITCH

Manual transmission.

- With both the engine and the ignition switch turned off, move the gear lever through all shift positions. The light should stay on until high gear is selected. If the light stays on in high gear, the circuit is grounded or the transmission switch is faulty. If the light does not go on at all, the circuit is open or the transmission switch has failed. You must repair the electrical circuit or replace the switch.
- Reconnect the transmission switch lead to the distributor modulator valve.

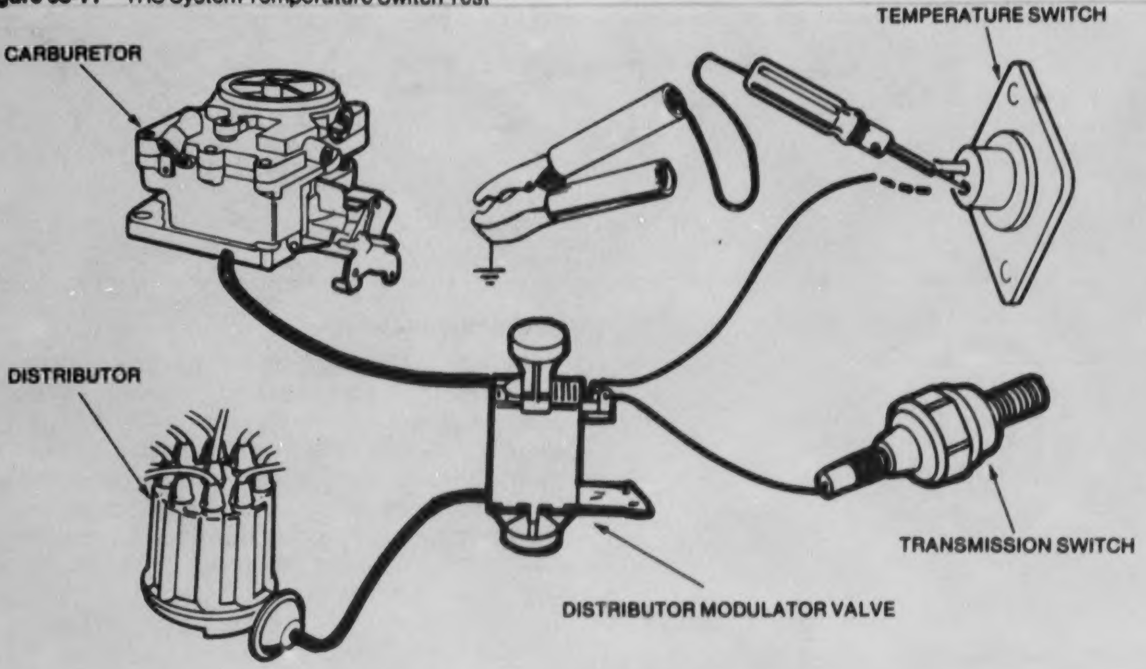
Automatic transmission.

- With the continuity test light connected as shown (see figure 38-10), start the engine and move the shift lever through all positions. The light should go out only when the shift lever is in the reverse position. If the light stays on in all positions, the circuit is grounded or the transmission switch is faulty. If the light does not go on at all, the circuit is open or the transmission switch has failed. You must repair the electrical circuit or replace the switch.
- Reconnect the transmission switch lead to the distributor modulator valve.

Temperature switch test.

STEP 1 Disconnect the temperature switch lead from the distributor modulator valve (see figure 38-11).

Figure 38-11 TRS System Temperature Switch Test



STEP 2 Connect a continuity test light to the temperature switch lead and to a good ground.

STEP 3 Turn the ignition switch on and warm the temperature switch with either your hand or with a sponge saturated with hot water.

- The light should go on when the switch temperature is above 65°F.
  If the light does not go on, the electrical circuit is open or grounded, or the temperature switch is faulty.

STEP 4 Cool the switch until its temperature is below 49°F. (Use a sponge or cloth saturated with cold water.)

- The light should go out.
  If the light does not go out, either the temperature switch has not cooled enough or it is faulty.

STEP 5 Reconnect the temperature lead to the distributor modulator valve.

Distributor modulator valve test. If both the transmission switch and the temperature switch are known to be good, repeat the TRS system test. Refer to the section on ***Testing the Ford TRS System,*** in this performance objective.

If the system still fails to function correctly, the distributor modulator valve is faulty, there is no venturi vacuum from the carburetor, or the vacuum hose is pinched, plugged, or improperly connected.

No maintenance is required for any component in the TCS system. If any component is not functioning properly, it should be replaced.

Other TCS Systems and Components

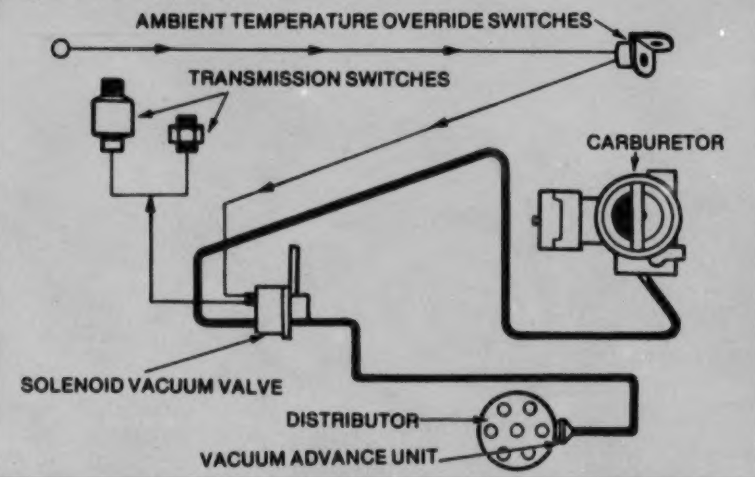
All TCS systems operate on the principle of cutting off vacuum advance during low gear operations and applying vacuum advance in high gear operations. Differences among the TCS systems involve the manner in which valves and switches are used to control the vacuum advance.

When you test other systems or make adjustments, always refer to your technical service manual and to the vehicle manufacturer's requirements.

American Motors Corporation

American Motors TCS systems also use an ambient temperature switch to compensate for hot or cold operations (see figure 38-12). Some AMC engines use a coolant temperature override switch that permits full-time manifold vacuum advance when the coolant temperature is below 160°F.

Figure 38-12 American Motors' TCS System

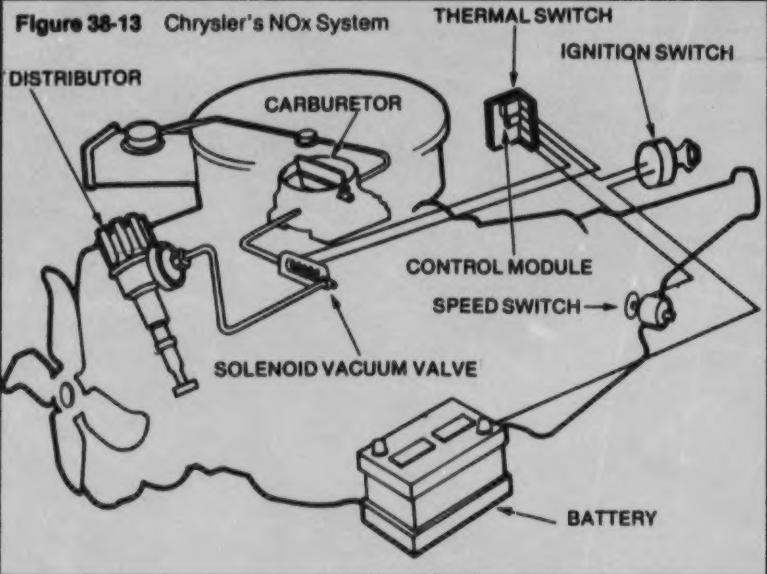

AMBIENT TEMPERATURE OVERRIDE SWITCHES
TRANSMISSION SWITCHES
CARBURETOR
SOLENOID VACUUM VALVE
DISTRIBUTOR
VACUUM ADVANCE UNIT

Some AMC transmission switches are driven by the speedometer gear so that they open above 34 mph and close below 25 mph.

Chrysler Corporation

Chrysler's TCS system for automatic transmissions includes a speed switch in line with the speedometer cable and mounted on the transmission housing (see figure 38-13). This system also uses a control module that is a combination vacuum-temperature switch mounted on the engine fire wall.

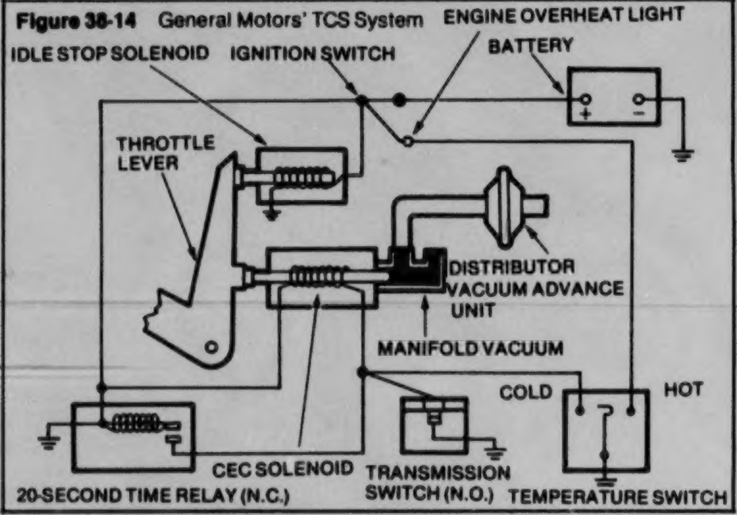
Figure 38-13 Chrysler's NOx System


THERMAL SWITCH
IGNITION SWITCH
DISTRIBUTOR
CARBURETOR
CONTROL MODULE
SPEED SWITCH
SOLENOID VACUUM VALVE
BATTERY

General Motors Corporation

General Motors' TCS system uses an idle stop solenoid in addition to a 20-second time relay switch (see figure 38-14). In place of a vacuum advance solenoid valve, some GM engines use a combined emission control (CEC) solenoid valve in which the solenoid plunger extends and contacts the throttle lever.

Figure 38-14 General Motors' TCS System

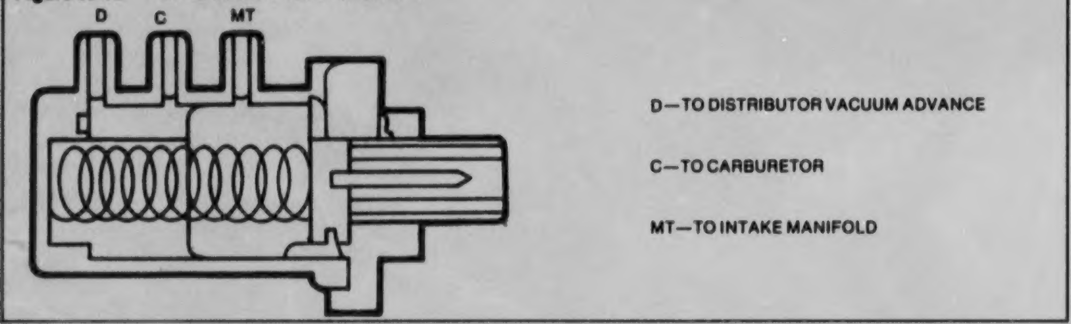

ENGINE OVERHEAT LIGHT
IDLE STOP SOLENOID
IGNITION SWITCH
BATTERY
+
−
THROTTLE LEVER
DISTRIBUTOR VACUUM ADVANCE UNIT
MANIFOLD VACUUM
COLD
HOT
CEC SOLENOID
TRANSMISSION SWITCH (N.O.)
20-SECOND TIME RELAY (N.C.)
TEMPERATURE SWITCH

Adapted from *Emission Control Service Manual. Domestic Car 1961-75.* © 1975 Mitchell Manuals, Inc. Used with permission of Mitchell Manuals, Inc.

In high gear operations, the CEC solenoid provides deceleration control at a preset value. Other GM TCS components are:

Thermo vacuum valve. Some GM V-8 engines use a thermo vacuum valve (see figure 38-15). It is used to advance the ignition timing at idle when the coolant temperature is high (226°F.). The valve allows the engine to run cooler and prevents engine overheating at idle speeds.

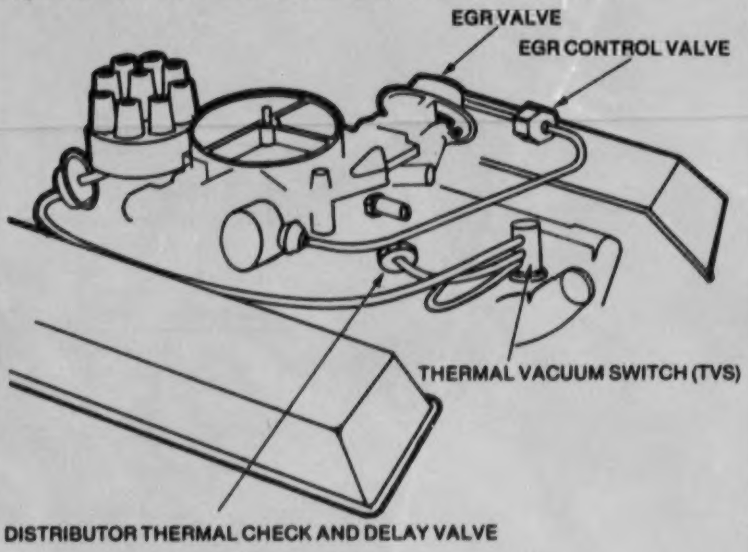
Figure 38-15 Thermo Vacuum Valve for GM V-8


D
C
MT
D—TO DISTRIBUTOR VACUUM ADVANCE
C—TO CARBURETOR
MT—TO INTAKE MANIFOLD

Adapted from *Emission Control Service Manual. Domestic Car 1961-75.* © 1975 Mitchell Manuals, Inc. Used with permission of Mitchell Manuals, Inc.

Thermal check and delay valve. On some V-8 engines with 4-bbl carburetors, a thermal check and delay valve is used in conjunction with a thermal vacuum switch (see figure 38-16). The valve is located in the vacuum hose between the carburetor ported spark port and the thermal vacuum switch center port (see C in figure 38-15). Its purpose is to retard the vacuum advance by equalizing the vacuum between the vacuum advance and the distributor when the underhood air temperature is below 50°F. However, when the coolant temperature reaches above 226°F., the valve is bypassed by the thermal vacuum switch, and timing is advanced.

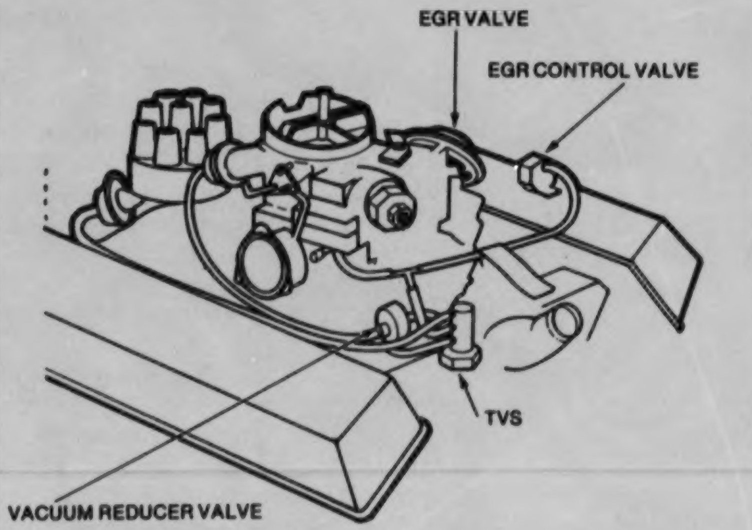
Figure 38-16 Thermal Check and Delay Valve


EGR VALVE
EGR CONTROL VALVE
THERMAL VACUUM SWITCH (TVS)
DISTRIBUTOR THERMAL CHECK AND DELAY VALVE

Adapted from *Emission Control Service Manual. Domestic Car 1961-75.* © 1975 Mitchell Manuals, Inc. Used with permission of Mitchell Manuals, Inc.

Vacuum reducer valve. Some V-8 engines with 2-bbl carburetors use a vacuum reducer valve in conjunction with the thermal vacuum switch (see figure 38-17). Its purpose is to reduce manifold vacuum to 3 inches below the advance vacuum, thereby preventing engine detonation when the coolant temperature rises above 226°F. This reduction of the manifold vacuum takes place at the same time that the thermal vacuum switch (MT port) opens and allows the distributor timing advance to occur.

Figure 38-17 Vacuum Reducer Valve



Adapted from *Emission Control Service Manual. Domestic Car 1961-75.* © 1975 Mitchell Manuals, Inc. Used with permission of Mitchell Manuals, Inc.

Before you test transmission controlled spark (TCS) systems or individual components, always refer to your technical service manual for the vehicle manufacturer's procedures and specifications.

No maintenance is required on any component in the TCS system. If any component is not functioning properly, it should be replaced.

When adjusting transmission switches for manual transmissions and idle stop solenoids, be sure to refer to the vehicle manufacturer's procedures and requirements in your technical service manual.

Turn to your Review Exercise Book and complete Exercise 15.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin any of the work activities until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

4. Test the operation of the transmission regulated spark system in a Ford vehicle (pages 136-38).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

5. Test the operation of these transmission-regulated spark system components in a Ford vehicle: transmission switch, temperature switch, and the distributor modulator valve (pages 138-41). Write down your results.

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

6. Look at American Motors, Chrysler, and General Motors vehicles and identify the transmission controlled spark system and its components in each vehicle (pages 141-45).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

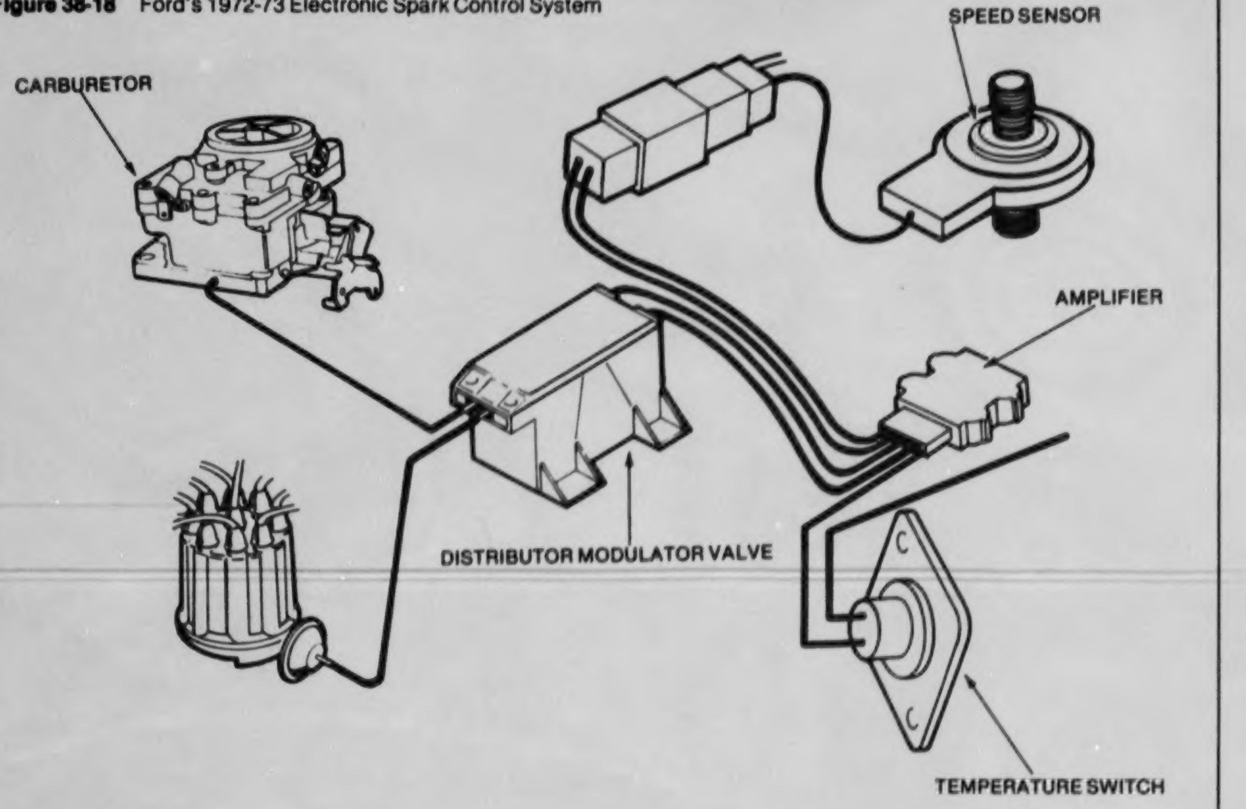
After you have finished these activities, go on to the next section.

ELECTRONIC SPARK CONTROL (ESC) SYSTEM

The electronic spark control system (ESC) regulates the supply of vacuum advance signal to the distributor through vehicle speed rather than through transmission gear selection. Hydrocarbons, carbon monoxide, and NOx emissions are reduced if the spark is retarded when the outside air temperature is above 65°F. and the vehicle is moving slower than a specified road speed.

The diagram of the electronic spark control system (see figure 38-18) illustrates the Ford 1972-73 components. Variations of this system appear on later model Ford vehicles and also on Chrysler Corporation vehicles. The work activities related to the Ford ESC system will help you to service and test similar systems.

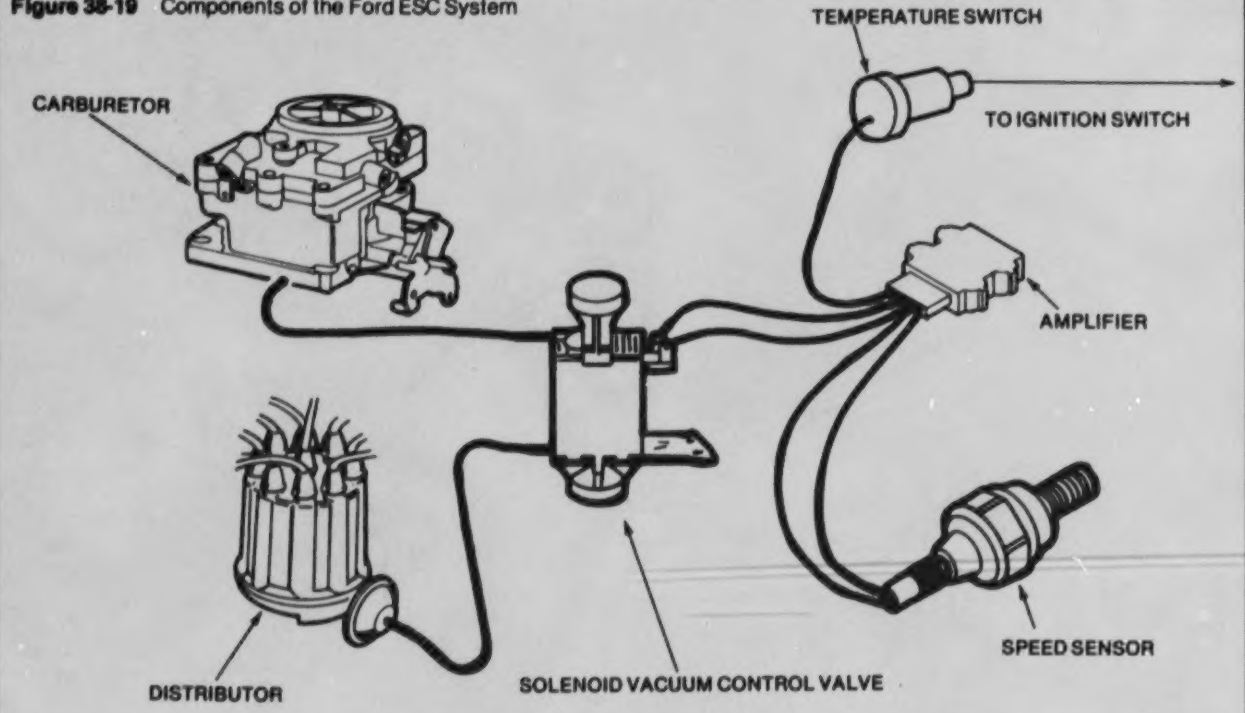
Figure 38-18 Ford's 1972-73 Electronic Spark Control System



Distributor modulator valve. This is an electric solenoid, or a solenoid vacuum control valve, that allows the vacuum supply to reach the distributor vacuum advance unit when de-energized. The distributor modulator valve is located in the vacuum line between the carburetor and the distributor vacuum advance unit. When the ESC system is activated, a control signal from the electronic amplifier energizes the vacuum control valve solenoid and blocks vacuum to the distributor.

Temperature switch. This switch, located in either the left-hand or right-hand doorpost, senses outside air temperature. (See figure 38-19.) At temperatures below 49°F. the temperature switch opens and allows normal vacuum advance regardless of road speed. When air temperatures are above 65°F., the switch closes and energizes the electronic amplifier, thereby shutting off vacuum advance.

Figure 38-19 Components of the Ford ESC System



Speed sensor. The speed sensor is a small generator located in the speedometer cable. As vehicle speed increases, the speed sensor generates a voltage signal that is proportionate to vehicle speed.

- At road speeds between 0 mph and 35 mph, a signal sent to the amplifier causes it to energize the distributor modulator valve, thereby blocking vacuum to the distributor vacuum advance unit. This results in retarded spark timing.
- At road speeds above 35 mph, the speed sensor causes the amplifier to de-energize the distributor vacuum advance unit so that normal vacuum advance is restored.
- When a deceleration speed of approximately 18 mph is reached, the amplifier energizes the distributor modulator valve, vacuum to the distributor is shut off, and the spark timing is again retarded.

Amplifier. The electronic amplifier located under the instrument panel is energized from the temperature switch when the temperature is above 65°F. The amplifier, in turn, signals the distributor modulator valve to energize and to block vacuum from reaching the distributor vacuum advance unit.

118

The amplifier is like a switchboard. It receives electric signals from the speed sensor and the temperature switch and it sends a signal to the distributor modulator valve. The nature of the signal it sends depends on the strength of the signal it receives.

- At 0 mph, the amplifier signals the distributor modulator valve to energize and to block vacuum from reaching the distributor vacuum advance unit.
- At 35 mph, the amplifier de-energizes the distributor vacuum advance unit and normal vacuum advance is restored.

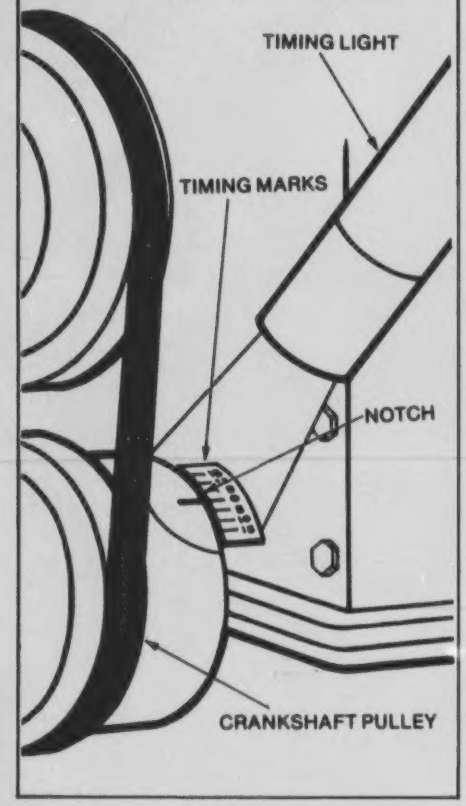
Summary of the Ford ESC System Operation

Temp. Sw.	Speed Sensor	Amplifier	Dist. Modulator Valve	Dist. Vacuum
Engine On (temperature below 49°F., no road speed)				
open	no signal	de-energized	de-energized	advance
Road Speed 0-35 mph (temperature below 49°F.)				
open	no signal	de-energized	de-energized	advance
Road Speed 0-35 mph (temperature above 65°F.)				
closed	signal	energized	energized	retarded
Road Speed above 35 mph (temperature above 65°F.)				
closed	signal	de-energized	de-energized	advance

Some engines have a coolant temperature override (CTO) vacuum switch. This switch is also called a distributor vacuum control valve or ported vacuum switch (PVS). When engine coolant temperature rises to between 220°F. and 230°F., the intake manifold vacuum overrides the distributor modulator valve and advances the spark timing until normal operating temperature is restored.

Turn to your Review Exercise Book and complete Exercise 16.

Figure 38-20 Check and Adjust Initial Timing



WORK ACTIVITIES

Before doing the work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to the work activity. Do not begin the work activity until you have your instructor's approval. If you're not sure that you can do the work activity, ask your instructor for help.

7. Look at several 1972-73 Ford vehicles and identify the electronic spark control (ESC) system of each and the main parts of each system (pages 146-49).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

After you have finished this activity, go on to the next section.

Testing the ESC System

Whenever an electronic spark control (ESC) system is suspected of a malfunction because of timing or timing advance problems, check the engine's initial timing setting and the distributor timing advance and retard mechanisms first. Eliminating a malfunction of these systems could correct what seemed to be a problem in the ESC system.

In addition to engine timing tests and corrections, the operation of the ESC system should be tested when the engine runs roughly, has spark knocks (pings), and shows an increase in fuel consumption.

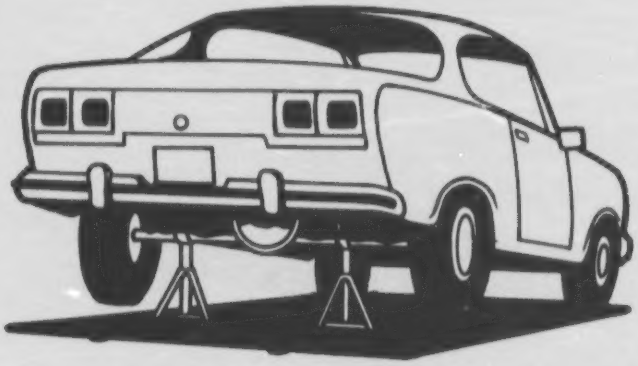
STEP 1 Check and adjust initial timing (see figure 38-20).

- Then, test the mechanical and vacuum advance and retard mechanisms, and make corrections if needed.
- For a review of procedures, refer to ***Preliminary Tests of the TCS system*** in this performance objective.

NOTE: Any initial, advance, or retard timing malfunctions that are discovered should be corrected before you proceed with any electronic spark control system tests.

STEP 2 Raise the rear wheels of the vehicle, and support the vehicle with jack stands (see figure 38-21).

Figure 38-21 Supporting Vehicle Properly with Jack Stands



CAUTION: Before proceeding, be sure that the jack stands are positioned properly and will hold the vehicle safely.

STEP 3 After you do the engine timing checks, unplug the vacuum hose that leads to the distributor vacuum control unit. Connect a vacuum gauge to the end of the vacuum hose (see figure 38-22).

Figure 38-22 Connecting the Vacuum Gauge to the Vacuum Hose

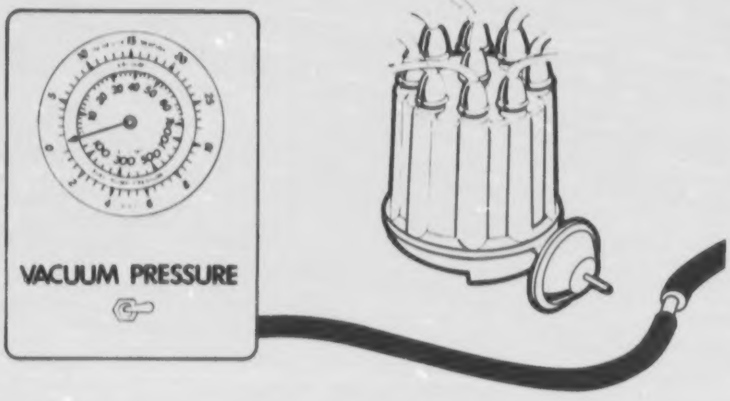


Figure 38-23 Gauge Reads Zero

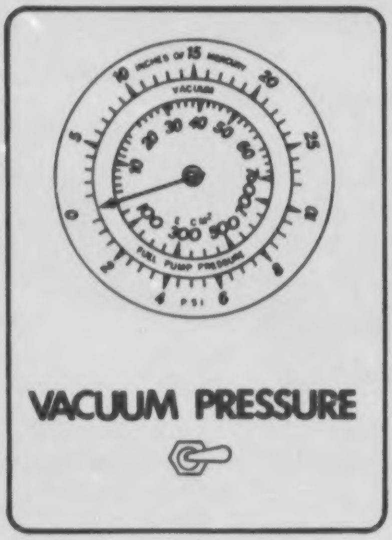
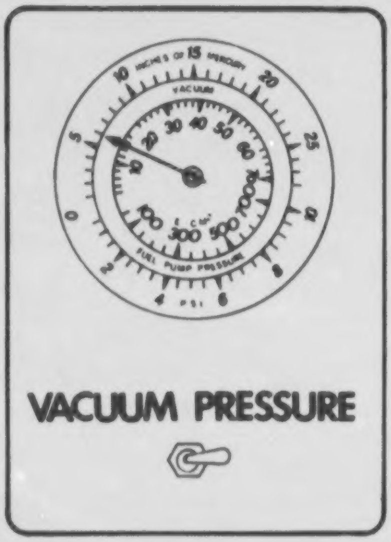


Figure 38-24 Gauge Reads 6 Inches of Vacuum



NOTE: Place the vacuum gauge so that it can be seen from the driver's seat.

STEP 4 The temperature switch should register above 65°F. If it doesn't, warm the switch with your hand or with a sponge saturated with hot water.

STEP 5 Look up the electronic amplifier specifications in your technical service manual. These specifications will provide the cut-in speed, the vehicle speed (mph) at which vacuum is allowed to reach the distributor vacuum advance unit. The manual also gives the cut-out speed, the point during deceleration when vacuum is blocked from the distributor vacuum advance.

- The specification chart will look something like this:

Electronic Amplifier Specifications

Case Color	Cut-In Speed (mph)	Cut-Out Speed (mph)
Black	23	18
White	28	18
Blue	33	18
Gray	35	18

- The case color column of the chart refers to the color of the amplifier case. In the sample chart above, for instance, the specification chart indicates that the color of the amplifier case is black, the cut-in speed is 23 mph and the cut-out speed on deceleration is 18 mph; if the case is blue, the cut-in speed is 33 mph and the cut-out speed is 18 mph.

STEP 6 Start the engine and engage the transmission.
The vacuum gauge should read zero (see figure 38-23).

STEP 7 Increase the engine RPM to the specified vehicle cut-in speed of 23, 28, 33, or 35 mph. At the specified cut-in speed, look at the vacuum gauge.
The vacuum gauge should register at least 6 inches of vacuum (see figure 38-24).

If there is no vacuum, throttle down the engine and check for the following:

- Be sure there is vacuum at the carburetor vacuum port.
- Check for blocked, pinched, disconnected, or incorrectly routed vacuum hoses.
- If there is a vacuum control valve, be sure it is open.

NOTE: If you find a problem with any of these conditions, correct it before you proceed with the ESC systems test.

STEP 8 If vacuum is present at the carburetor and the inspection of the system shows nothing wrong, disconnect one or both wires at the distributor modulator valve.

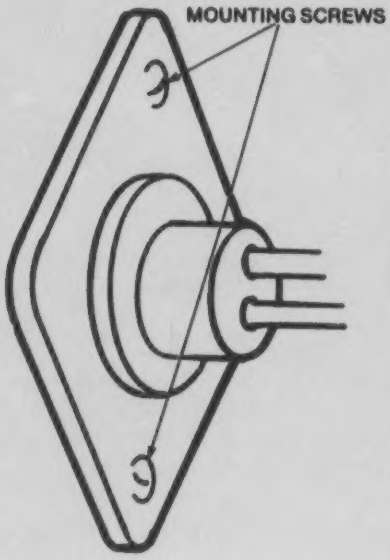
STEP 9 Speed up the engine to the specified vehicle cut-in speed again, and then throttle down the engine.

- If there is no vacuum at all, replace the distributor modulator valve.

STEP 10 If the gauge registers vacuum ***below*** the ***cut-in*** speed, trouble exists in the ESC system. It will be necessary to test the individual system components to find the defective part(s).

STEP 11 Turn the engine off.

Figure 38-25 Temperature Switch



Testing the Ford ESC Components

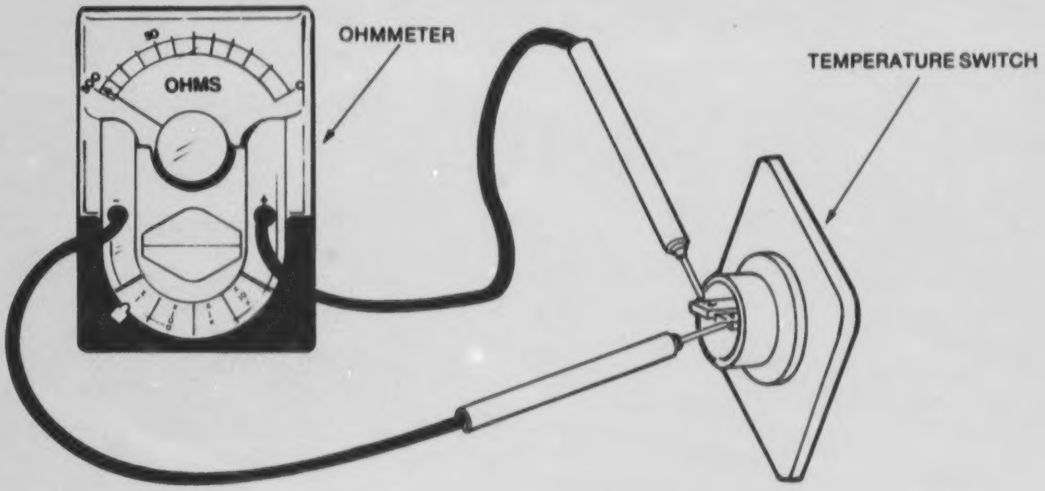
When the test of the ESC system's operation indicates a malfunction, it is necessary to test each ESC component to locate the faulty part.

Temperature switch test.

STEP 1 Remove the temperature switch from the doorpost. Disconnect the wiring to the switch (see figure 38-25).

STEP 2 Connect an ohmmeter to the switch's wiring terminals (see figure 38-26).

Figure 38-26 Using an Ohmmeter to Check Temperature Switch



- With the switch resting in the palm of your hand, allow it to warm up.
- An ohmmeter reading with the switch at 65°F. or higher indicates a good switch.

STEP 3 Chill the switch with ice water. Check the ohmmeter reading again.

- At temperatures below 49°F., the switch should be open and no reading should register if the switch is good.
- If a reading does register, the temperature switch should be replaced.

Power supply test.

STEP 1 Using a continuity test light, ground one tester lead and connect the other lead to the temperature switch connector at the instrument panel wiring (red-yellow wire).

STEP 2 Turn on the ignition key. The continuity test light should light.

- If the test light does not light, check the wiring and the ignition switch.
- Correct any malfunctions before you proceed with other tests.

Speed sensor test.

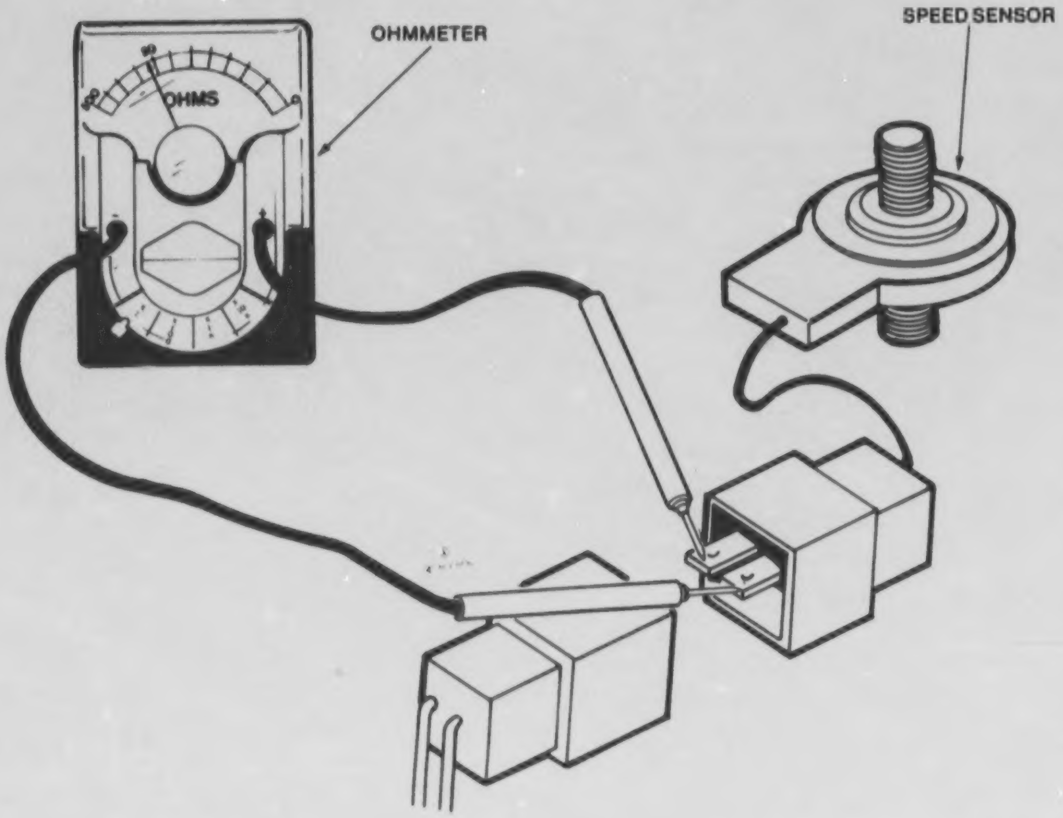
STEP 1 To test the speed sensor, first look up the speed sensor specifications for the ESC system in your technical service manual. The chart will look something like this:

Speed Sensor Specifications

Resistance . . . . . . 40-60 ohms @ room temperature
Coil to case resistance . . . . open circuit

STEP 2 Disconnect the speed sensor wiring connector. Connect the ohmmeter test leads to the terminals of the speed sensor (see figure 38-27).

Figure 38-27 Using Ohmmeter to Check Terminals of the Speed Sensor



- Resistance at room temperature should be 40 ohms to 60 ohms.

STEP 3 Check the ohms resistance between the black wire and the speed sensor case.

- The circuit should be open, so there should be no ohmmeter reading.

If either reading varies from what is specified, replace the speed sensor.

Electronic amplifier.

If the tests described above have failed to locate the problem, replace the electronic amplifier.

No maintenance is required of any component in the ESC system. If any component is not functioning properly, it should be replaced.

Turn to your Review Exercise Book and complete Exercise 17.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work acitvity below. Do not begin the work activities until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

8. Using a 1972-73 Ford vehicle, test the operation of the electronic spark control (ESC) system (pages 146-53).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

9. Using a 1972-73 Ford vehicle, test the operation of these electronic spark control (ESC) system components: temperature switch, power supply, and speed sensor (pages 153-56).

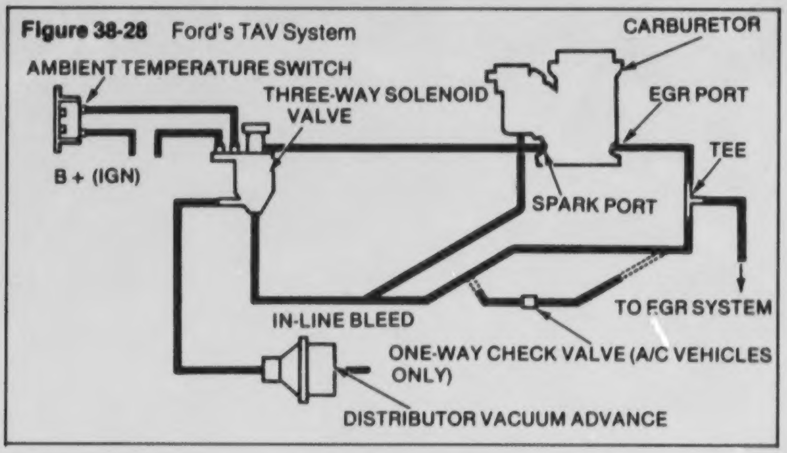
CHECK YOUR WORK WITH YOUR INSTRUCTOR.

After you have finished these activities, go on to the next section.

Ford's Temperature Activated Vacuum (TAV) System

On the 1973 Ford 250-inch engine with automatic transmission, a temperature activated vacuum (TAV) system is used. The TAV system is designed to control distributor vacuum advance by selecting *either* carburetor spark port vacuum or carburetor EGR port vacuum. Selection of either port vacuum is controlled by an ambient temperature switch only. Notice that a speed sensor is omitted in this system (see figure 38-28).

Figure 38-28 Ford's TAV System


CARBURETOR
AMBIENT TEMPERATURE SWITCH
THREE-WAY SOLENOID VALVE
EGR PORT
TEE
B + (IGN)
SPARK PORT
TO EGR SYSTEM
IN-LINE BLEED
ONE-WAY CHECK VALVE (A/C VEHICLES ONLY)
DISTRIBUTOR VACUUM ADVANCE

Components. The TAV system has these components:

- Temperature Switch. Located in either the left-hand or right-hand doorpost, the temperature switch senses outside air temperatures. For the TAV system, air temperature above 60°F. activates a three-way solenoid valve that allows vacuum to reach the distributor vacuum advance unit from the ***carburetor EGR port.*** When the air temperature is below 49°F., the three-way solenoid valve is de-energized, and vacuum is allowed to reach the distributor vacuum advance unit from the ***carburetor spark port.*** Notice that the TAV and EGR systems do not work together but, rather, as separate systems.
- In-line vacuum bleed. Located in the vacuum line from the carburetor EGR port, the in-line vacuum bleed operates to purge the vacuum line of any excessive gasoline vapors.
- Three-way solenoid valve. This solenoid valve is operated by the air temperature switch. Depending on the outside temperature, the valve opens and closes vacuum to the distributor vacuum advance unit from either the carburetor spark port or the EGR port.

Testing the TAV System. As with other ignition timing control systems, you should check the engine initial timing settings and distributor timing advance and retard mechanisms before you test the temperature activated (TAV) system. Eliminating a malfunction in these timing systems could correct what seemed to be a problem in the TAV system.

In addition to the engine timing tests and corrections, the operation of the TAV system should be tested when the engine runs roughly, has spark knock (pings), and shows an increase in fuel consumption.

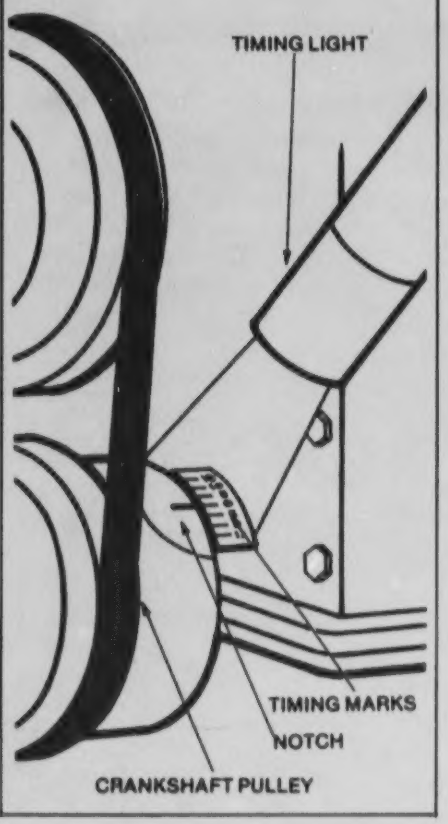
To test the TAV system:

STEP 1 Check and adjust the initial timing (see figure 38-29). Then test the mechanical and vacuum advance and retard mechanisms, and make corrections, if necessary.

- For a review of procedures, refer to the section on ***Preliminary Tests of the TCS System*** in this performance objective.

NOTE: Any initial, advance, or retard timing malfunctions that are discovered should be corrected before you proceed with any TAV systems test.

Figure 38-29 Set the Timing



STEP 2 When you are sure the engine timing is functioning properly, unplug the vacuum hose that leads to the distributor vacuum control unit (see figure 38-30). Install a tee fitting into the vacuum line and attach the vacuum gauge.

Figure 38-30 Tee Fitting Installed in Vacuum Hose

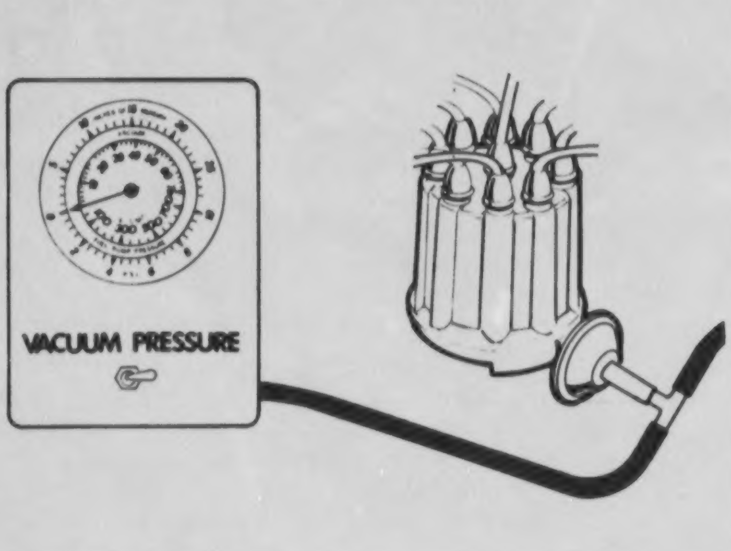

VACUUM PRESSURE

Figure 38-31 Vacuum Reading Is Zero

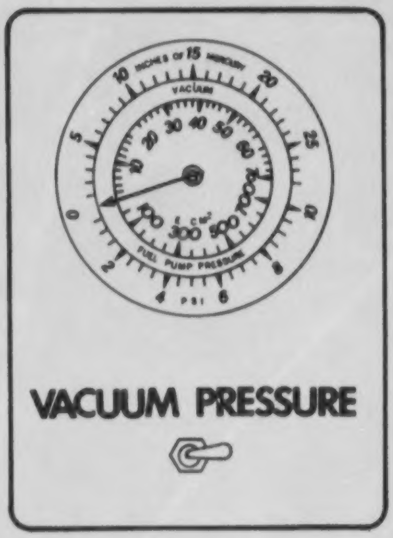
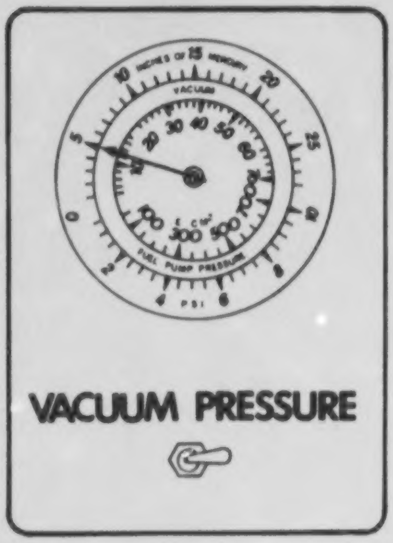

INCHES OF 15 MERCURY
VACUUM
0
5
10
20
25
30
FUEL PUMP PRESSURE
2
4
PSI
6
8
VACUUM PRESSURE

Figure 38-32 Vacuum Reading Is 5 Inches


INCHES OF 15 MERCURY
VACUUM
0
5
10
20
25
30
FUEL PUMP PRESSURE
2
4
PSI
6
8
VACUUM PRESSURE

STEP 3 Connect a tachometer to the engine.

STEP 4 When the air temperature is 65°F. or higher, start the engine and allow it to idle.

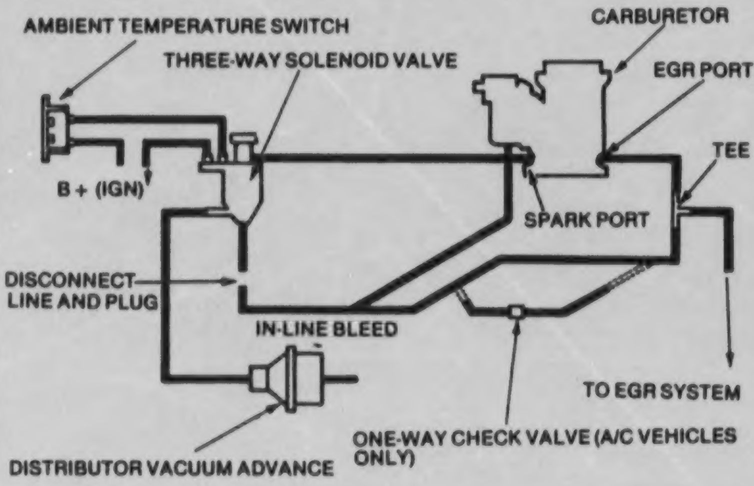
- The vacuum reading should be zero (see figure 38-31).

STEP 5 Increase the engine speed to 1500 RPM or slightly higher.

- The vacuum reading should be 5 inches or more (see figure 38-32).

STEP 6 With the engine speed at 1500 RPM, disconnect the EGR port vacuum line from the three-way solenoid and plug the line (see figure 38-33).

Figure 38-33 Disconnecting EGR Port Vacuum Line and Plugging It


AMBIENT TEMPERATURE SWITCH
THREE-WAY SOLENOID VALVE
CARBURETOR
EGR PORT
TEE
B + (IGN)
SPARK PORT
DISCONNECT LINE AND PLUG
IN-LINE BLEED
TO EGR SYSTEM
ONE-WAY CHECK VALVE (A/C VEHICLES ONLY)
DISTRIBUTOR VACUUM ADVANCE

- The vacuum reading should drop to zero.

STEP 7 Unplug the EGR port vacuum line and reconnect it to the solenoid. Disconnect one of the three-way solenoid valve electrical leads (see figure 38-34).

Figure 38-34 Disconnecting One of the Three-Way Solenoid Valve Electrical Leads

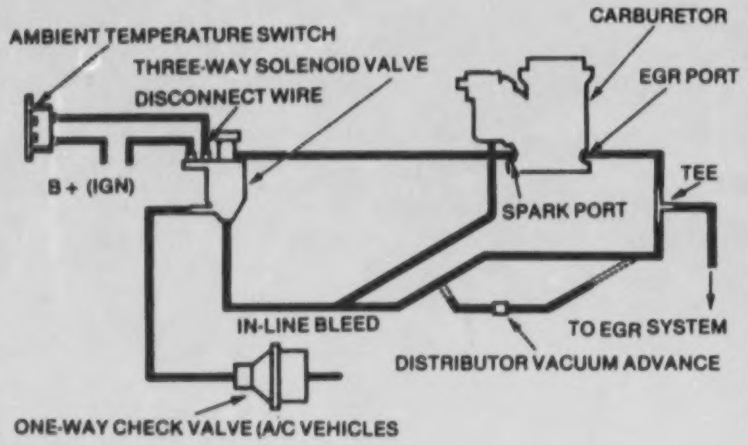
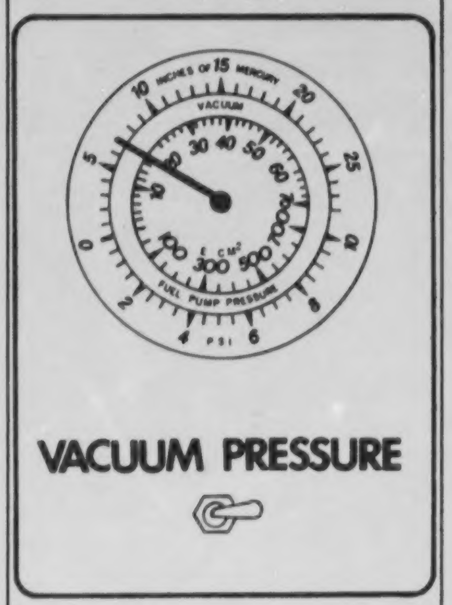

AMBIENT TEMPERATURE SWITCH
THREE-WAY SOLENOID VALVE
DISCONNECT WIRE
CARBURETOR
EGR PORT
B + (IGN)
TEE
SPARK PORT
IN-LINE BLEED
TO EGR SYSTEM
DISTRIBUTOR VACUUM ADVANCE
ONE-WAY CHECK VALVE (A/C VEHICLES

Figure 38-35 Vacuum Reading is 7 Inches


INCHES OF MERCURY
0
5
10
15
20
25
30
VACUUM
10
20
30
40
50
60
70
100
300
500
700
FUEL PUMP PRESSURE
2
4
6
8
PSI
VACUUM PRESSURE

- The vacuum reading should read more than 6 inches with the engine speed slightly above 1500 RPM (see figure 38-35), indicating that the TAV system is operating properly.
- If the TAV system is not operating properly, test the individual components of the system to find the faulty part. Refer to your technical service manual for the correct testing procedures to follow and for the vehicle manufacturer's specifications.

Turn to your Review Exercise Book and complete Exercise 18.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work activity below. Do not begin the work activities until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

10. Using a 1973 Ford vehicle that has a 250-inch engine and an automatic transmission, identify the temperature activated vacuum (TAV) system and the main parts of the system (pages 157-58).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

11. Using a 1973 Ford vehicle that has a 250-inch engine and an automatic transmission, test the operation of the temperature activated vacuum (TAV) system (pages 158-61).

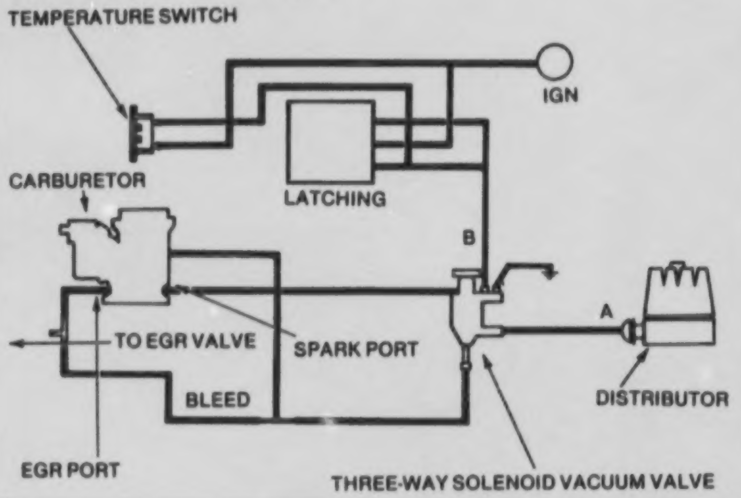
CHECK YOUR WORK WITH YOUR INSTRUCTOR.

After you have finished these activities, go on to the next section.

Ford Cold Temperature Activated Vacuum (CTAV) System

On 1974 Ford engines, a cold temperature activated vacuum (CTAV) system is used (see figure 38-36). Modeled after the TAV system, the CTAV system is designed to control distributor vacuum advance by selecting *either* carburetor spark port vacuum or carburetor EGR port vacuum. The selection of the port vacuum is controlled by an ambient temperature switch. The new feature, a latching relay, goes on when the temperature switch closes and stays on until the ignition switch is turned off. This means that once the temperature switch is closed (above 65°F.), EGR port vacuum is supplied to the distributor at all times.

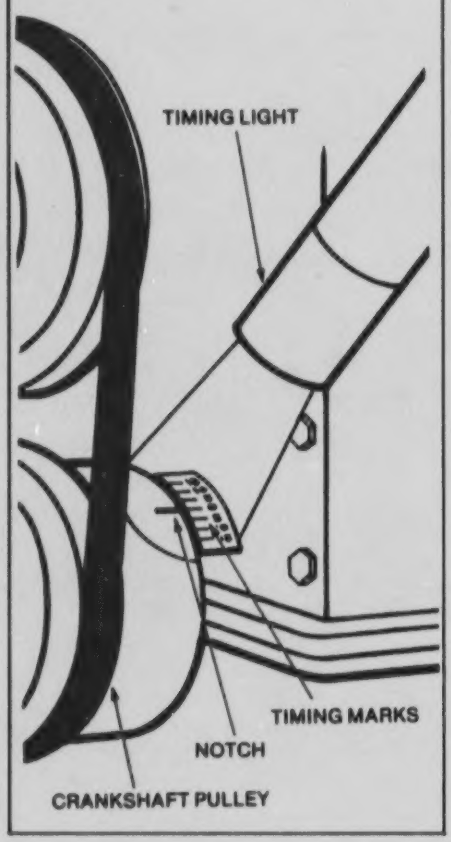
Figure 38-36 Ford's CTAV System



The CTAV system consists of these components:

- Temperature switch. The ambient temperature switch for the CTAV system is located on the carburetor air cleaner. When air temperature in the engine compartment is above 65°F., the three-way solenoid valve allows vacuum to reach the distributor vacuum advance unit from the ***carburetor EGR port.*** When the air temperature is below 49°F., the three-way solenoid valve allows vacuum to reach the distributor vacuum advance unit from the ***carburetor spark port.***
- Latching relay. The latching relay, which is normally *off*, is energized by the closing of the temperature switch. Once the relay is *on*, it stays on until the ignition switch is turned off, regardless of whether the temperature switch is open or closed. EGR port vacuum is therefore supplied to the distributor vacuum advance unit at all times, once the temperature switch closes (above 65°F.).
- In-line vacuum bleed. Located in the vacuum line from the carburetor EGR port, the in-line vacuum bleed operates to purge the vacuum line of any excessive gasoline vapors.
- Three-way solenoid valve. The solenoid valve is operated by the air temperature switch. Depending on the temperature in the engine compartment, the valve opens and closes vacuum to the distributor vacuum advance unit from either the carburetor spark port or the EGR port (see figure 38-36).

Figure 38-37 Set the Timing



Testing the CTAV system. Check engine initial timing settings and distributor timing advance and retard mechanisms before you test the cold temperature activated vacuum (CTAV) system.

Eliminating a malfuntion of these timing systems could correct what seemed to be a problem in the CTAV system.

In addition to the engine timing tests and corrections, the operation of the CTAV system should be tested when the engine runs roughly, has spark knock (pings), or shows an increase in fuel consumption.

The CTAV vacuum system. To test the operation of the CTAV vacuum system:

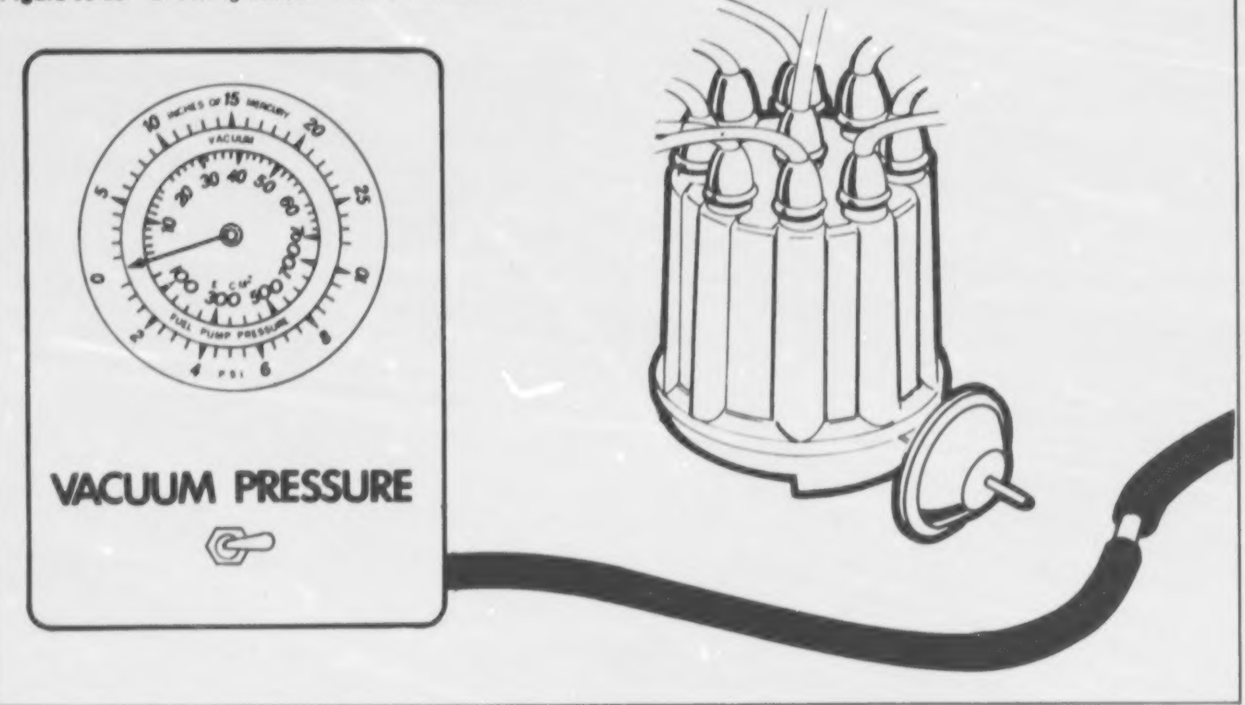
STEP 1 Check and adjust the initial timing.

- Then test the mechanical and vacuum advance and retard mechanisms and make corrections, if necessary (see figure 38-37).
- For a review of procedures, refer to the section on ***Preliminary Tests of the TCS System*** in this performance objective.

NOTE: Any initial, advance, or retard timing malfunctions that are discovered should be corrected before you proceed to any CTAV systems test.

STEP 2 When you are sure that the engine timing is functioning properly, unplug the vacuum hose that leads to the distributor vacuum control unit. Connect a vacuum gauge to the vacuum hose at the distributor (see figure 38-38).

Figure 38-38 Checking Vacuum Hose at the Distributor


INCHES OF 15 MERCURY
VACUUM
FUEL PUMP PRESSURE
PSI
VACUUM PRESSURE

STEP 3 Connect a tachometer to the engine.

STEP 4 Be sure that the temperature switch registers over 65°F. Disconnect the electrical lead at the three-way solenoid valve (see figure 38-39: point B).

Figure 38-39 Disconnected Lead at Three-Way Solenoid Valve

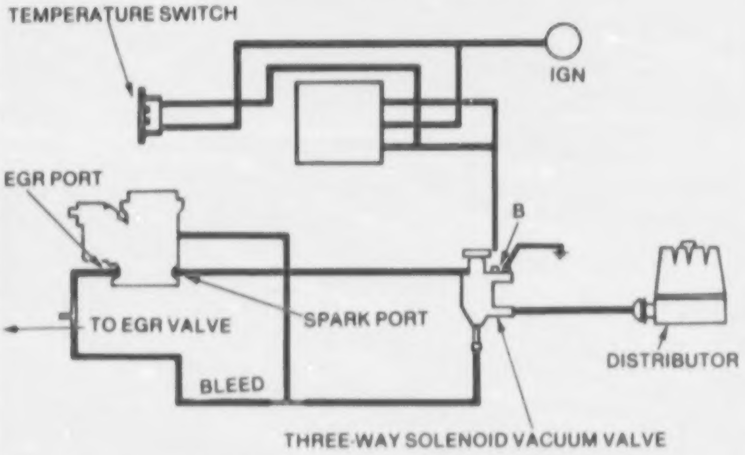
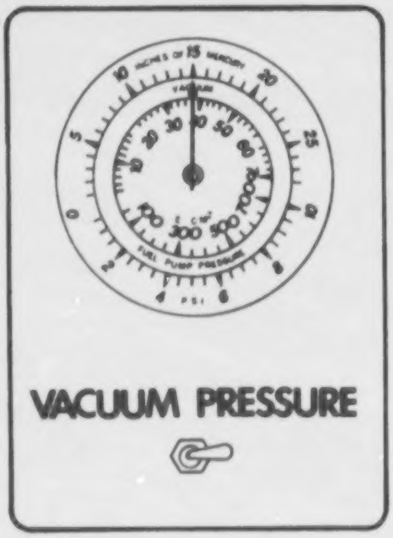

TEMPERATURE SWITCH
IGN
EGR PORT
B
TO EGR VALVE
SPARK PORT
DISTRIBUTOR
BLEED
THREE-WAY SOLENOID VACUUM VALVE

Figure 38-40 Reading Should Be Approximately 15 Inches


INCHES OF 15 MERCURY
VACUUM
FUEL PUMP PRESSURE
PSI
VACUUM PRESSURE

STEP 5 Operate the engine at 1500 RPM.

- The vacuum should be approximately 15 inches (see figure 38-40).
- If there is no vacuum, check the vacuum source back to the carburetor spark port.

STEP 6 Reconnect the electrical lead to the three-way solenoid valve at point B (see figure 38-39).

- There should be low vacuum or none at all.
- If there is vacuum, check the solenoid valve ground and the electrical source back to the ignition switch.

STEP 7 Operate the engine at 3000 RPM.

- The vacuum should be approximately 9 inches (see figure 38-41).
- If there is no vacuum, check the vacuum source back to the carburetor EGR port.

STEP 8 When you have finished the CTAV vacuum tests, remove the tachometer and the vacuum gauge from the engine.

The CTAV electrical system. To test the operation of the CTAV electrical system, follow the testing points given in Figure 38-42:

Figure 38-41 Reading Should Be 9 Inches

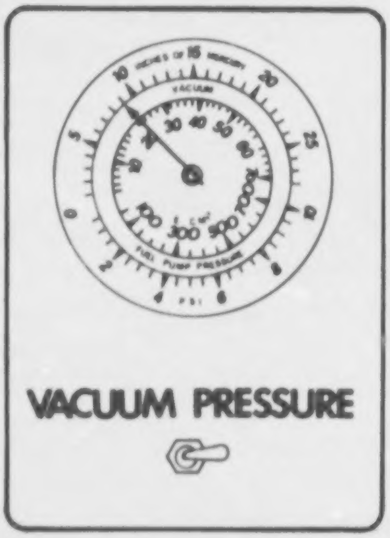
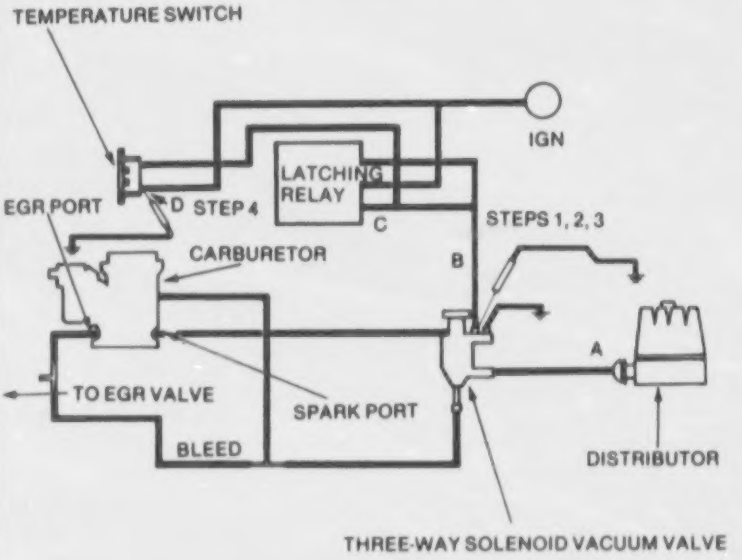

INCHES OF 15 MERCURY
VACUUM
FUEL PUMP PRESSURE
PSI
VACUUM PRESSURE

Figure 38-42 Checking the CTAV Electrical System


TEMPERATURE SWITCH
IGN
LATCHING RELAY
EGR PORT
D STEP 4
C
STEPS 1, 2, 3
CARBURETOR
B
A
TO EGR VALVE
SPARK PORT
BLEED
DISTRIBUTOR
THREE-WAY SOLENOID VACUUM VALVE

STEP 1 Connect a continuity test light at point B (temperature switch terminal). Disconnect the wiring connector at point D (temperature switch). Turn the ignition on.

- There should be no light.
- If there is light, replace the latching relay.

STEP 2 Reconnect the wiring connector at point D (temperature switch).

- There should be a light.
- If there is no light, check the temperature switch and the wiring back to the ignition switch.

STEP 3 Disconnect the wiring connector from point C (latching relay).

- There should be a light.
- If there is no light, replace the latching relay.

STEP 4 Connect the continuity test light to the temperature switch terminal at point D.

- Cool the temperature switch to a temperature below 49° F.
- The light should go out.
- If the light stays on, replace the temperature switch.

STEP 5 Remove the continuity test light and make sure all electrical connections are tight.

Turn to your Review Exercise Book and complete Exercise 19.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin the work activities until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

12. Using a 1974 Ford vehicle, identify the cold temperature activated vacuum (CTAV) system and the main parts of the system (pages 162-63).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

13. Using a 1974 Ford vehicle, test the operation of the CTAV vacuum system (pages 164-66).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

14. Using a 1974 Ford vehicle, test the operation of the CTAV electrical system (pages 166-67).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

After you have finished these activities, go on to the next section.

Chrysler Orifice Spark Advance Control (OSAC) System

To aid in control of NOx, Chrysler used an orifice spark advance control system on all 1973-1974 engines and some 1975 and later vehicles (see figure 38-43).

Figure 38-43 Chrysler OSAC System

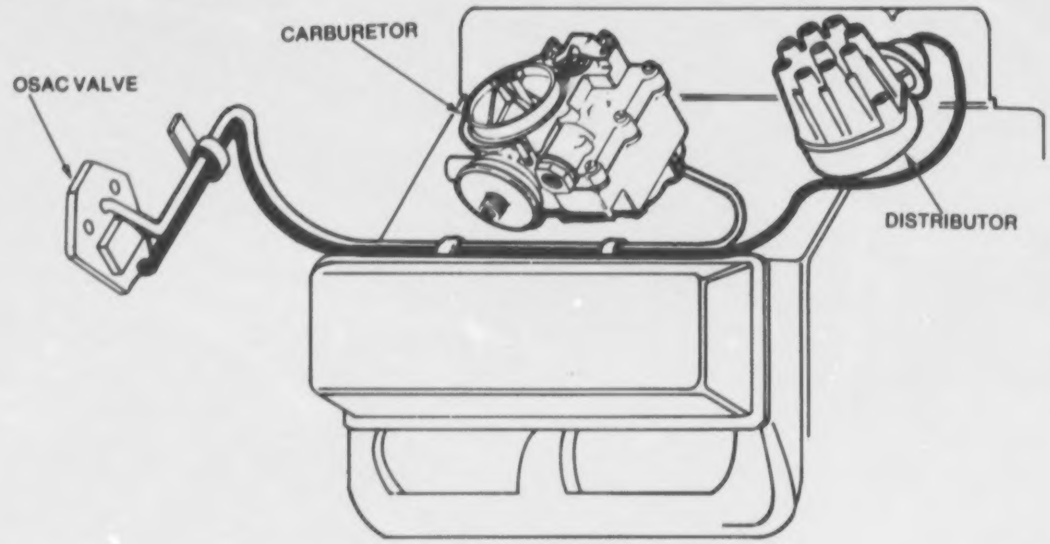
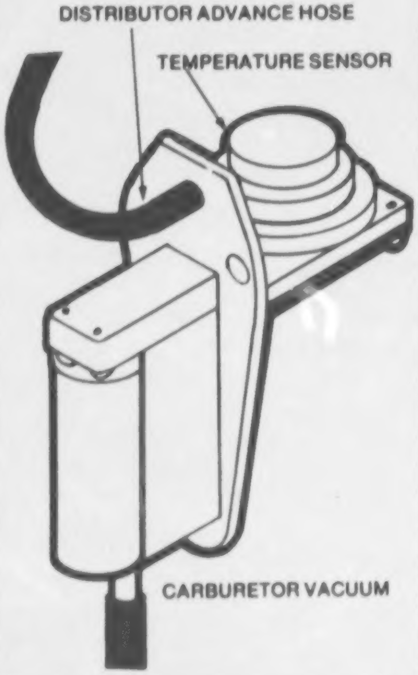


Figure 38-44 OSAC Valve on Chrysler System

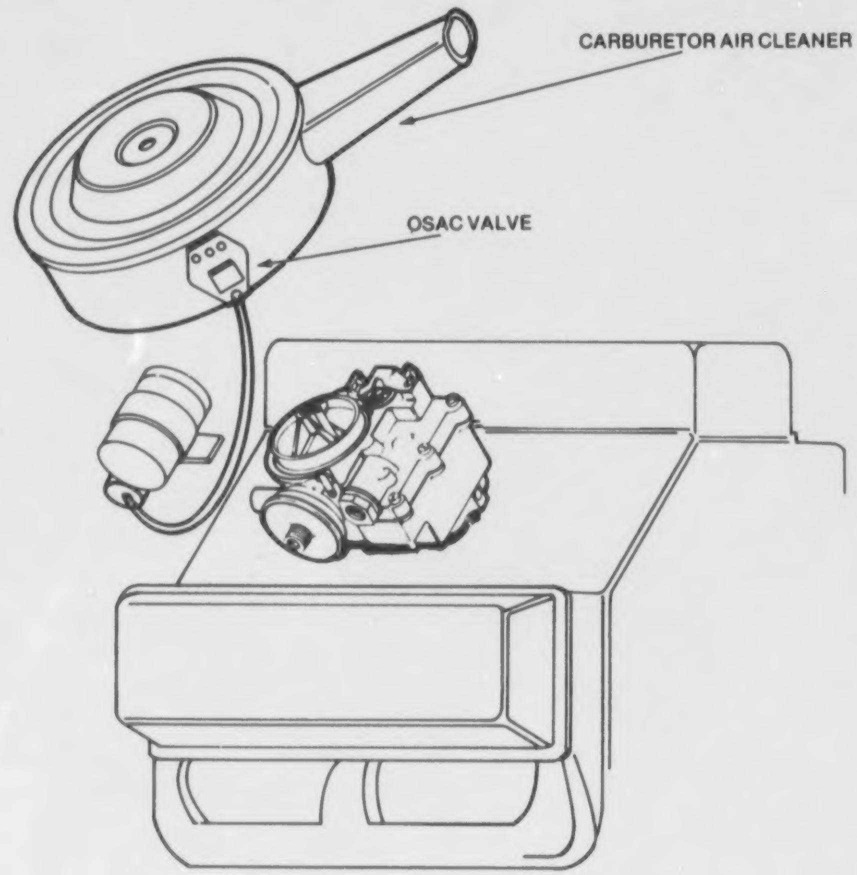


Distributor vacuum advance is controlled by a tiny orifice in the OSAC valve. When the engine changes from idle to partial throttle opening, the orifice delays the change in ported vacuum to the distributor by 17 to 27 seconds, depending upon the valve model. When the engine changes back from partial throttle to idle during deceleration, ported vacuum is directed to the distributor instantaneously for immediate vacuum advance.

The principal component of the orifice spark advance control system is the OSAC valve (see figure 38-44). The valve is located in the vacuum line between the carburetor vacuum port and the distributor vacuum advance unit. Prior to March 15, 1973, the OSAC valve was mounted on the engine fire wall and contained a temperature sensor. The temperature sensor controls the valve to delay ported vacuum only when the ambient temperature is 60°F. or higher. At temperatures below 60°F., full vacuum advance at the distributor is permitted at all times.

On vehicles built after 15 March 1973, the OSAC valve is located on the carburetor air cleaner (see figure 38-45). These later vehicles also have no temperature sensor, so the valve can operate to delay ported vacuum at all ambient temperatures.

Figure 38-45 OSAC Valve Vacuum Hose Routing (Typical 1974)



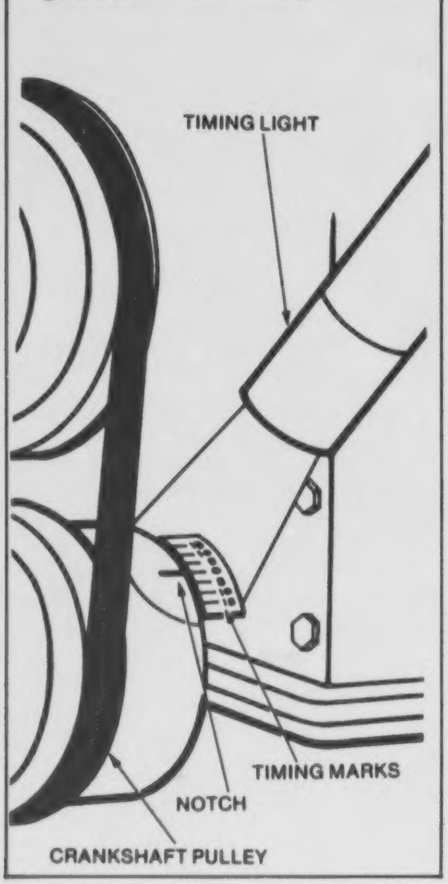
Testing the OSAC system. Check engine initial timing settings and distributor timing advance and retard mechanisms first before you test the orifice spark advance control (OSAC) system. Eliminating a malfunction of these timing systems could correct what seemed to be a problem in the OSAC system.

In addition to the engine timing tests and corrections, the operation of the OSAC system should be tested when the engine runs roughly, has spark knock (pings), and shows an increase in fuel consumption.

To test the operation of the OSAC system:

STEP 1 Check and adjust the initial timing (see figure 38-46).

Figure 38-46 Set the Timing


TIMING LIGHT
TIMING MARKS
NOTCH
CRANKSHAFT PULLEY

- Test the mechanical and vacuum advance mechanisms, and make corrections as needed.
- For a review of procedures, refer to the section on ***Preliminary Tests of the TCS System*** in this performance objective.

NOTE: All initial, advance, or retard timing malfunctions should be corrected before you proceed with any OSAC systems test.

STEP 2 Inspect all vacuum hoses for leaks or damage.

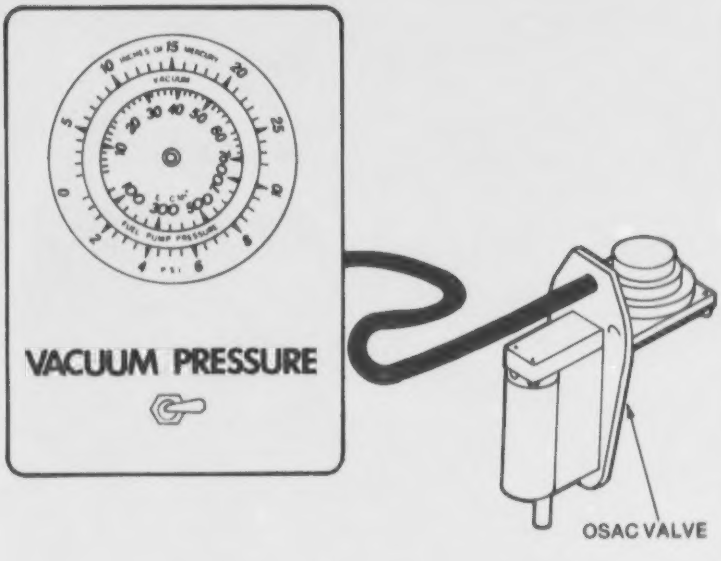
STEP 3 Connect a tachometer to the engine.

STEP 4 Start the engine and place the transmission in Neutral.

STEP 5 With the engine running at 2000 RPM, disconnect the vacuum hose that leads from the OSAC valve to the distributor vacuum advance mechanism.

STEP 6 Connect a vacuum gauge to the fitting on the OSAC valve and watch the movement of the vacuum gauge pointer (see figure 38-47).

Figure 38-47 Vacuum Gauge Connected to OSAC Valve


INCHES OF MERCURY
VACUUM
FUEL PUMP PRESSURE
PSI
VACUUM PRESSURE
OSAC VALVE

GOOD	The vacuum increase is very gradual, taking 15 to 20 seconds to reach a stabilized level. The time varies on different engines and vehicles, depending on the OSAC valve used.
BAD	If the vacuum immediately goes up to the level of the manifold vacuum, the OSAC valve is defective and must be replaced.
BAD	If no vacuum increase is noted, the OSAC valve is not operating and must be replaced.

NOTE: On Chrysler Corporation vehicles manufactured before March 15, 1973, the temperature in the area of the OSAC valve must be above 65°F. Remember, on these models, the OSAC valve is controlled by a temperature sensor.

Turn to your Review Exercise Book and complete Exercise 20.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to the work activity. Do not begin the work activity until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

15. Using a 1973-74 Chrysler Corporation vehicle, test the orifice spark advance control (OSAC) system (pages 170-72).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

After you have finished this activity, go on to the next section.

Chrysler Thermal Ignition Control (TIC) Valve

Thermal ignition control (TIC) valves are used on many 1971-1974 Chrysler Corporation vehicles. The valve is part of the OSAC system. Its purpose is to reduce the possibility of engine overheating under extremely high-temperature operating conditions.

The thermostatic ignition control (TIC) valve is located in the thermostat housing of the engine coolant system (see figure 38-48). The TIC valve acts as a safety valve. When engine coolant reaches 225°F. at idle, the TIC valve switches from carburetor vacuum to manifold vacuum, permitting full vacuum advance and advancing the ignition timing. This, in turn, increases the engine speed and helps return the engine to the normal operating-temperature.

Figure 38-48 Chrysler's TIC Valve System

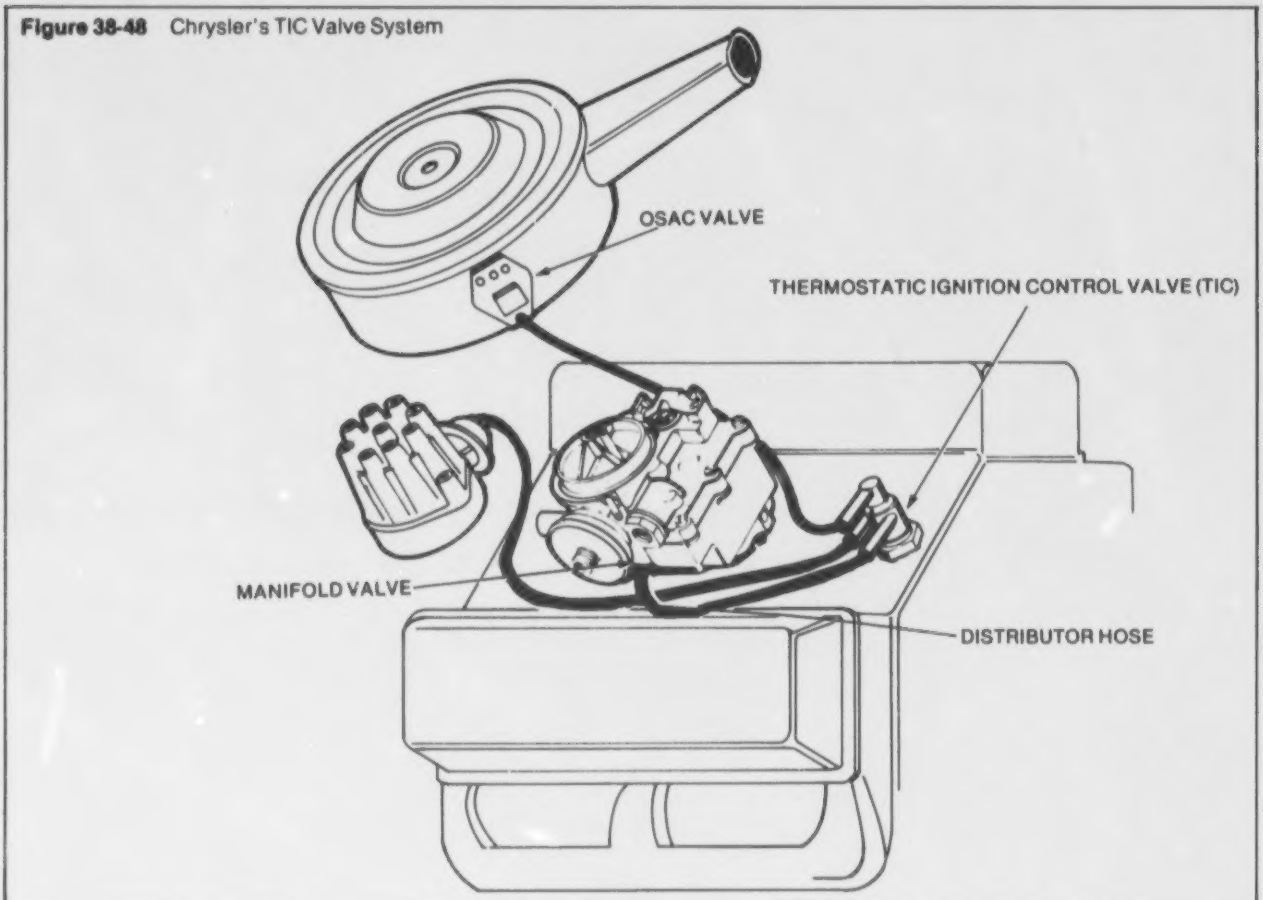
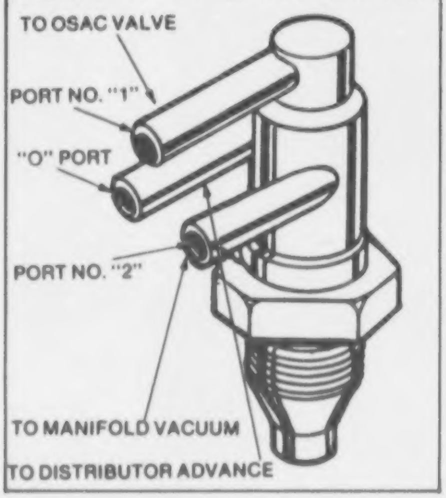

OSAC VALVE
THERMOSTATIC IGNITION CONTROL VALVE (TIC)
MANIFOLD VALVE
DISTRIBUTOR HOSE

Figure 38-49 Enlarged View of TIC Valve


TO OSAC VALVE
PORT NO. "1"
"O" PORT
PORT NO. "2"
TO MANIFOLD VACUUM
TO DISTRIBUTOR ADVANCE

Testing the TIC valve.

STEP 1 Check the vacuum hoses for proper routing and for leaks or damage (see figure 38-50). Check the engine coolant level.

Figure 38-50 Check the Vacuum Hoses for Leaks

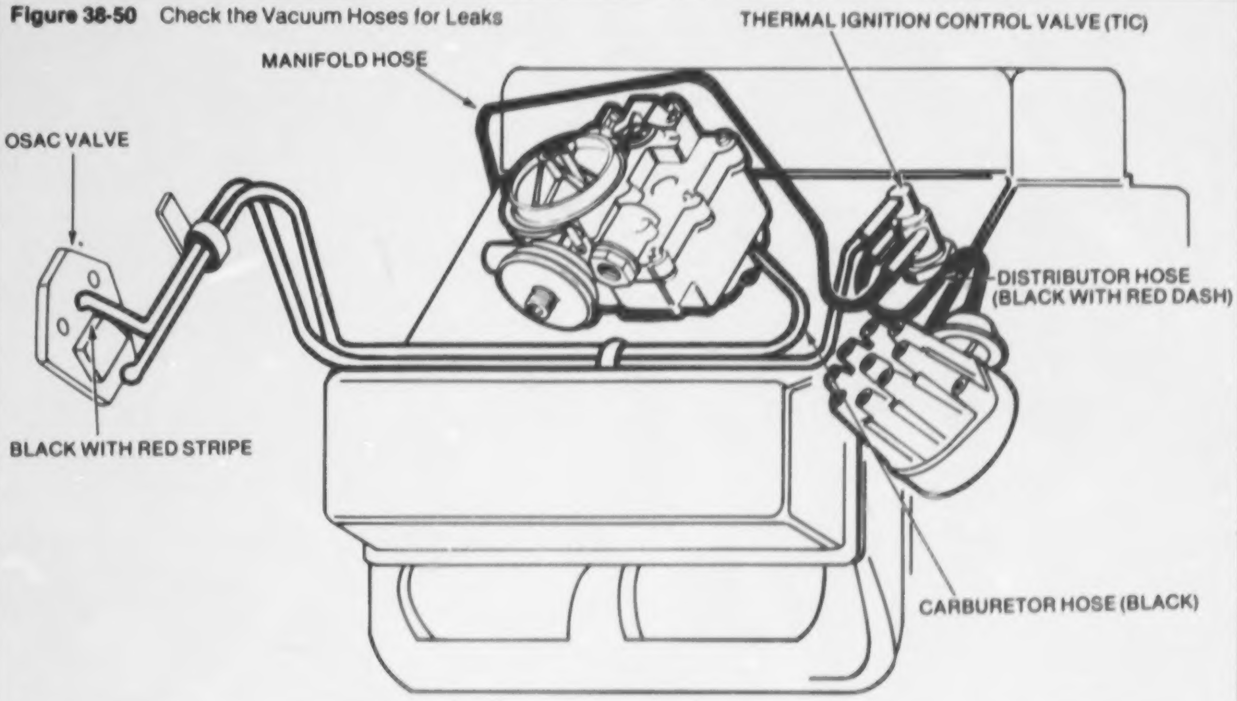
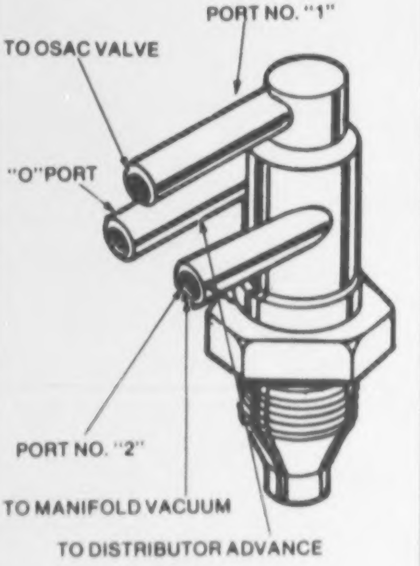

THERMAL IGNITION CONTROL VALVE (TIC)
MANIFOLD HOSE
OSAC VALVE
DISTRIBUTOR HOSE (BLACK WITH RED DASH)
BLACK WITH RED STRIPE
CARBURETOR HOSE (BLACK)

Figure 38-51 TIC Valve with Numbered Ports


PORT NO. "1"
TO OSAC VALVE
"O" PORT
PORT NO. "2"
TO MANIFOLD VACUUM
TO DISTRIBUTOR ADVANCE

STEP 2 Attach a tachometer to the engine.

STEP 3 Bring the engine to normal operating temperature. Be sure the choke is fully open.

STEP 4 Disconnect the distributor solenoid ground lead to the carburetor, and adjust idle speed to 600 RPM.

STEP 5 Disconnect the manifold vacuum hose from the port number 2 of the TIC valve (see figure 38-51). Plug the hose and check the engine idle speed.

GOOD There is no change in the idle speed.

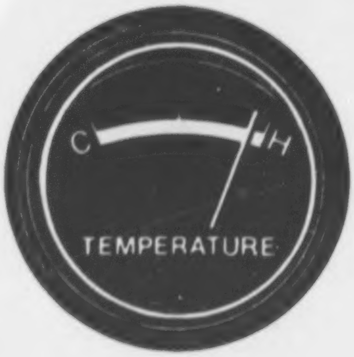
BAD If the idle speed drops 100 RPM or more, the valve should be replaced.

STEP 6 Unplug and reinstall the vacuum hose to the port number 2.

STEP 7 Cover the radiator to increase engine coolant temperature.

CAUTION: Do Not Overheat Engine.

Figure 38-52 Always Check Temperature Gauge for Engine Overheating



STEP 8 Idle the engine until its temperature reaches approximately 225°F. (see figure 38-52).

NOTE: On models that have temperature gauges, abnormally high temperature is indicated by the indicator needle reaching the top of the bar (235°F.).

GOOD The engine speed increases 100 RPM or more as the engine temperature reaches approximately 225°F.

BAD Engine speed does not increase by 100 RPM or more at approximately 225°F.

- The TIC valve is defective and must be replaced.

STEP 9 Idle the engine, with the radiator uncovered, until the temperature is again normal. Readjust the idle RPM.

Turn to your Review Exercise Book and complete Exercise 21.

WORK ACTIVITIES

Before doing the work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to the work activity. Do not begin the work activity until you have your instructor's approval. If you're not sure that you can do the work activity, ask your instructor for help.

16. Using a 1973-74 Chrysler Corporation vehicle, test the operation of the thermal ignition control (TIC) valve (pages 000-000)

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

When you have finished this activity, ask your instructor to return your pretest on Performance Objective 38. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 39

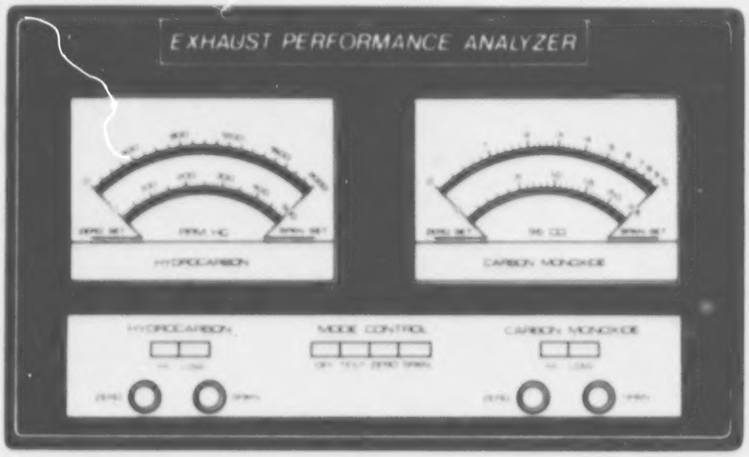
TEST EXHAUST EMISSIONS, USING A HYDROCARBON-CARBON MONOXIDE (HC-CO) TESTER

INTRODUCTION

In this performance objective, you'll learn how to use an exhaust emissions tester, read emission test results, and relate the test results to possible engine malfunctions. You'll also learn how to use the exhaust emissions tester to test the operation of many other emission control systems that are on the vehicles.

The exhaust emission tester is also called an exhaust performance analyzer, an infrared tester, and an HC-CO tester (see figure 39-1). Its function is to measure the amounts of hydrocarbon (HC) and carbon monoxide (CO) emissions in an exhaust gas sample from an operating engine.

Figure 39-1 HC-CO Tester


EXHAUST PERFORMANCE ANALYZER
ZERO SET
PPM HC
SPAN SET
HYDROCARBON
ZERO SET
% CO
SPAN SET
CARBON MONOXIDE
HYDROCARBON
HI LOW
MODE CONTROL
OFF TEST ZERO SPAN
CARBON MONOXIDE
HI LOW
ZERO
SPAN
ZERO
SPAN

From the test results, you'll be able to:

- analyze engine and/or emission control system malfunctions
- check and adjust carburetor idle mixture screws to meet federal standards for exhaust emission levels
- check exhaust emission levels after tune-up to determine whether all work was performed properly.

The exhaust emission tester is becoming a most effective diagnostic tool when used with an engine analyzer and a scope.

The two gauges or meters of the exhaust emission tester measure hydrocarbons and carbon monoxide.

Hydrocarbons (HC). This emission is actually unburned gasoline. It is the amount of raw gas emitted into the exhaust after combustion. On the tester gauge, hydrocarbons are measured in parts per million (PPM). PPM states the volume relationship between the number of parts of one substance (HC) to one million parts of another substance (AIR).

When vehicles built since 1971 are properly tuned, HC readings should be under 200 PPM. For older vehicles, the HC reading should be under 300 PPM.

Carbon monoxide (CO). This emission, a very poisonous gas, is a direct result of incomplete combustion. CO is formed when *partial* burning of the fuel mixture takes place because of a lack of oxygen. The tester is used to measure the percentage of carbon monoxide that is present in the exhaust gases. The larger the percentage of CO in a sample of exhaust, the more CO there is in the exhaust mixture.

When vehicles built since 1971 are properly tuned, CO readings should be below 1%. For older vehicles, readings should be below 3%.

After you have finished all the activities for Performance Objective 39, your instructor will use a checklist like the one below to evaluate your work.

PERFORMANCE CHECKLIST—P.O. 39

Your instructor will provide an HC-CO tester and vehicle for this peformance objective. Test the exhaust emissions on the vehicle and record your test results. All of the performances below must be accomplished.

Student Performances	**Instructor Ratings**		
	Acceptable	Not Acceptable	Omit
1. Warms up, calibrates, and hooks up the HC-CO tester to a vehicle.			
2. Tests the HC-CO levels of a vehicle and analyzes the results.			
3. Uses HC-CO tester to adjust the carburetor idle mixture of a vehicle engine to specifications.			
4. Performs a PCV system test.			
5. Performs an accelerator pump test.			
6. Performs an air pump test.			
7. Performs an EGR system test.			
8. Tests a restricted air cleaner.			
9. Tests ignition misfire.			
10. Tests crossed spark plug wires.			
11. Tests the spark plug gap.			
12. Tests a vacuum leak.			
13. Follows all appropriate safety precautions.			
14. Time.			

SAMPLE

Testing Exhaust Performance with Hydrocarbon-Carbon Monoxide (HC-CO) Tester

When you test engine exhaust performance, always follow the tester manufacturer's procedures for the make and model of the tester you're using. Ask your instructor how to hook up, calibrate, and use the tester. In general, follow the testing steps listed below:

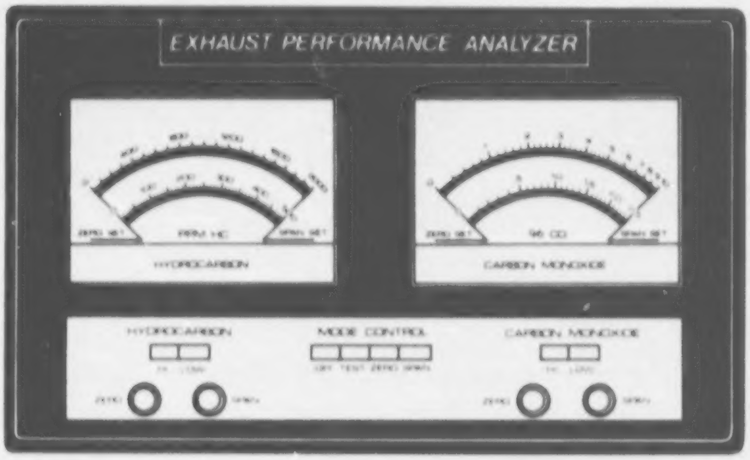
STEP 1 Attach a tachometer to the vehicle engine.

STEP 2 Warm up and calibrate the exhaust emission tester.

STEP 3 For the tester shown in Figure 39-2, select the HI scale range for both the HC and the CO gauges. The button for the HI scale is located below each gauge. When you use the HI scale, you'll be reading the upper scale on the gauges.

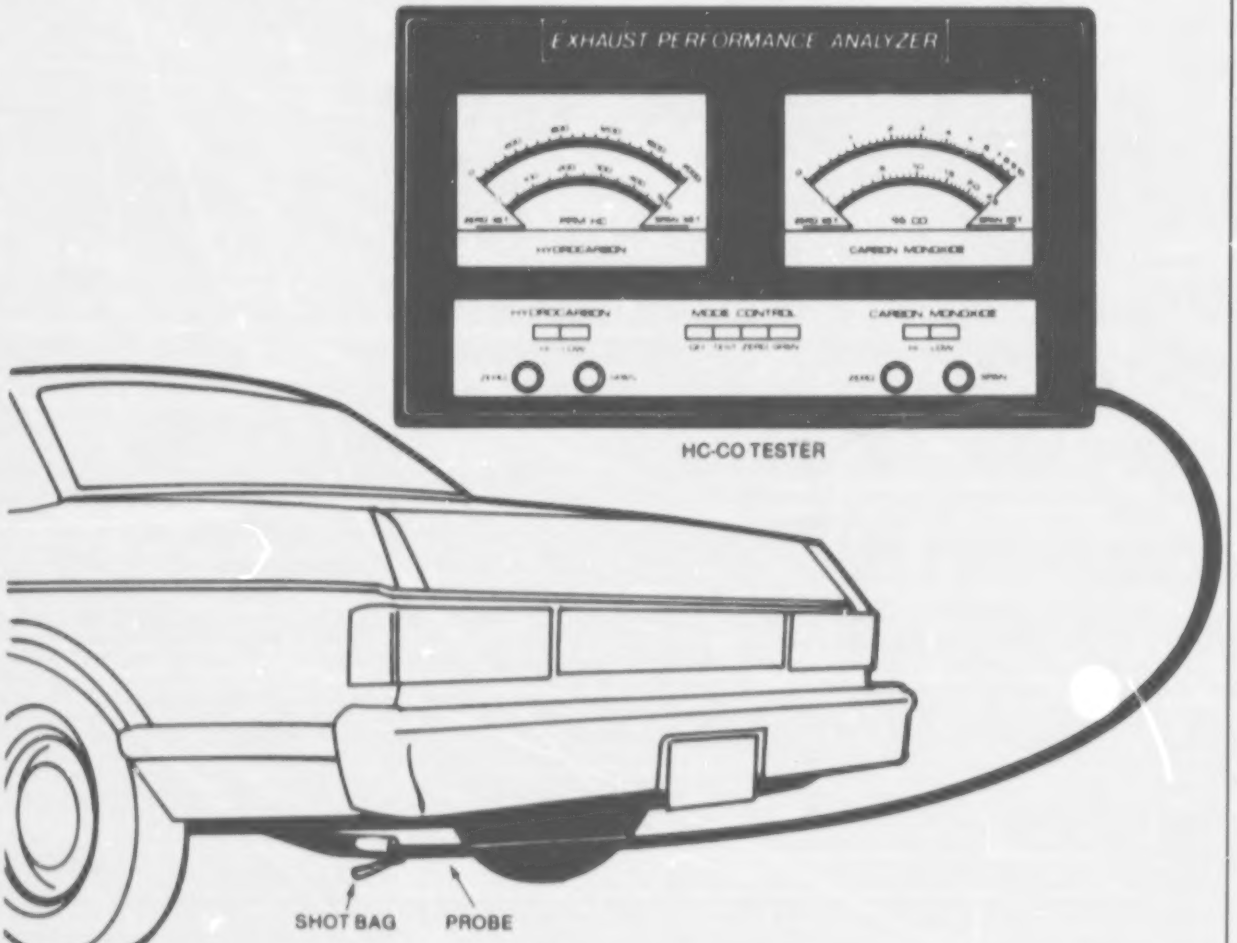
NOTE: Later, if the HC gauge reads less than 500 ppm or the CO gauge reads less than 2.5%, look at the lower scales (LO button) for easier reading.

Figure 39-2 HC-CO Tester Showing HI-LO Scale Settings


EXHAUST PERFORMANCE ANALYZER
ZERO SET
PPM HC
SPAN SET
HYDROCARBON
ZERO SET
% CO
SPAN SET
CARBON MONOXIDE
HYDROCARBON
HI LOW
ZERO
SPAN
MODE CONTROL
OFF TEST ZERO SPAN
CARBON MONOXIDE
HI LOW
ZERO
SPAN

STEP 4 Insert the tester sampling probe approximately 12 inches into the vehicle tail pipe (see figure 39-3). The probe you're using may have a bag of heavy steel pellets called a shot bag attached to it. If it does, toss the bag forward of the probe under the vehicle. This keeps the probe from coming out of the tail pipe when the engine is operating.

Figure 39-3 Connect HC-CO Tester to Tail Pipe


EXHAUST PERFORMANCE ANALYZER
PPM HC
HYDROCARBON
% CO
CARBON MONOXIDE
HYDROCARBON
HI LOW
MODE CONTROL
OFF TEST ZERO SPAN
CARBON MONOXIDE
HI LOW
ZERO
SPAN
ZERO
SPAN
HC-CO TESTER
SHOT BAG
PROBE

- Be sure the vehicle's exhaust system is airtight. Air leaking into the system could dilute the exhaust gas and affect the readings.
- When you test vehicles equipped with dual exhaust, be sure to test each side separately to insure that an exhaust sample from each bank of cylinders has been analyzed.

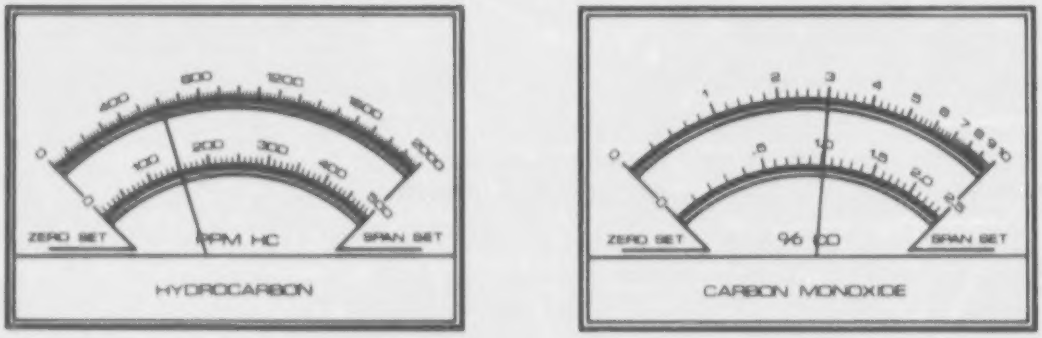
NOTE: For Chrysler and Volkswagon vehicles equipped with catalytic converters, insert the tester probe at a special tap upstream from the catalytic converter.

For any vehicle that has a catalytic converter but no tap, the exhaust gases can be tested at the EGR valve exhaust port. To do this, remove the EGR valve, but leave the vacuum hose connnected to it. Plug the vacuum opening in the intake manifold with masking tape or other suitable adhesive. Insert the emission control tester probe into the exhaust port in the intake manifold.

STEP 5 Operate the engine at idle and at normal operating temperatures. Accelerate the engine slightly to assure release of the fast-idle cam on the carburetor.

STEP 6 Note and record the readings from both the HC and CO gauges.

Figure 39-4 Sample Readings on HC-CO Tester



STEP 7 Operate the engine at 2500 RPM, and record the readings for both the HC and CO gauges. Example readings are given in Figure 39-4.
HC = 600 ppm
CO = 3%

NOTE: If the HC gauge reads less than 500 ppm or the CO gauge reads less than 2.5 percent, switch to the LO gauge scales for easier reading.

STEP 8 Stop the engine and depress the tester *zero* switch button. This will keep the tester ready for use without further warm-up.

NOTE: Only idle readings will be accurate for electronic fuel-injected vehicles that have no load on the engine. Testing of these engines at 2500 RPM must be done on a dynamometer.

Interpreting Emission Tester Readings

When you read emission tester results, keep in mind the comparison of tester readings to manufacturer's specifications. The specifications alert you to which readings are considered too high and which ones are too low. Knowing the causes of a reading that is too high will help you to analyze engine performances. In fact, many tune-up specialists claim that when HC and CO readings are within specifications, the engine does not need a tune-up. When the emission tester readings do ***not*** meet the manufacturer's specifications, the vehicle engine must be tuned before making any final carburetor adjustments.

To find HC-CO manufacturer's specifications, look at the decal, ***Vehicle Emission Control Information***, in the engine compartment. It will look something like Figure 39-5.

Figure 39-5 Vehicle Emission Control Data as It Appears in the Engine Compartment

XZ
380-400 CU. IN.
2 BBL. CARB.
GM 104-2

VEHICLE EMISSION CONTROL INFORMATION
GENERAL MOTORS CORPORATION

MAKE IDLE SPEED AND TIMING ADJUSTMENTS WITH ENGINE AT NORMAL OPERATING TEMP., CHOKE OPEN, AIR COND. OFF, AIR CLEANER INSTALLED, AND DISTR. VACUUM LINE DISCONNECTED AND PLUGGED. RECONNECT DISTR. VACUUM LINE WHEN ADJUSTMENTS ARE COMPLETED.

SET PARKING BRAKE AND BLOCK DRIVE WHEELS.

1. DISCONNECT FUEL TANK HOSE FROM VAPOR CANISTER.
2. ADJUST CARBURETOR SOLENOID SCREW TO SPECIFIED RPM.
3. SET DWELL AND TIMING AT SPECIFIED RPM. RESET IDLE SPEED IF NECESSARY.
4. ADJUST CARBURETOR IDLE CAM SCREW TO SPECIFIED BASE IDLE RPM ON LOW STEP OF CAM WITH SOLENOID WIRE DISCONNECTED. RECONNECT WIRE AFTER ADJUSTMENT.
5. IDLE MIXTURE HAS BEEN SET AT THE FACTORY. IF IDLE MIXTURE ADJUSTMENT IS NECESSARY, SEE SERVICE MANUAL FOR PROCEDURES. IDLE MIXTURE SPECIFICATIONS ARE SHOWN AT RIGHT.
6. REMOVAL OF MIXTURE SCREW CAPS AND/OR ALTERING IDLE MIXTURE TO OTHER THAN SPECIFICATIONS MAY VIOLATE FEDERAL AND OTHER STATE LAWS.
7. RECONNECT FUEL TANK HOSE TO VAPOR CANISTER.

AIR-EGR EXHAUST EMISSION CONTROL	TRANSMISSION	
	AUTOMATIC	MANUAL
DWELL	30°	30°
TIMING (°BTC @ RPM)	8° @ 600	0° @ 900
SOLENOID SCREW (RPM)	600 (DR)	900 (N)
BASE IDLE SCREW (RPM)	500 (DR)	500 (N)
LEAN DROP IDLE MIXTURE (RPM)	650-600 (DR)	1000-900 (N)
MAX. IDLE CO (% @ RPM)	0.5 @ 600 (DR)	0.5 @ 900 (N)

SEE SERVICE MANUAL FOR ADDITIONAL INFORMATION FUEL REQUIREMENTS — USE 91 OCTANE OR HIGHER.

PRINTED IN USA THIS VEHICLE CONFORMS TO U.S. E.P.A. REGULATIONS APPLICABLE TO 1974 NEW YEAR MOTOR VEHICLES. PT. NO. 346258

Courtesy General Motors Corporation

Notice that the last item listed in the AIR-EGR Exhaust Emission Control column is ***Max Idle CO (% @ RPM)***. For vehicles with automatic transmissions, the carbon monoxide (CO) reading should be 0.5 percent at 600 RPM with the transmission in drive range. For vehicles with manual transmissions, the CO reading should be 0.5 percent at 900 RPM with the transmission in neutral.

Notice also that hydrocarbon specifications are not given. Whenever HC-CO specifications cannot be found, the following suggested specifications apply:

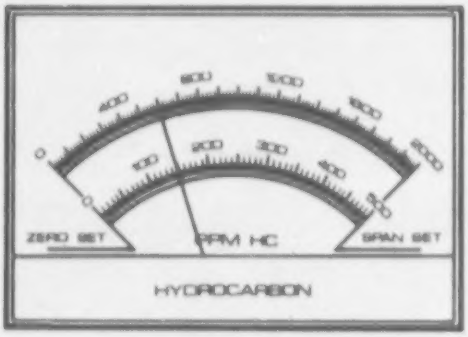
- Emission-controlled vehicles, 1971 and newer:
  HC less than 200 ppm
  CO less than 1 percent

- Noncontrolled vehicles:
  HC less than 300 ppm
  CO less than 3 percent

Now refer to the exhaust emission test results of the vehicle you tested. If the hydrocarbon test readings are too high (600 ppm), as in Figure 39-6, they are a result of any misfire caused by:

- absence of a spark
- timing of a spark
- length of time the plugs fire (poor timing)
- fouled plugs
- broken ignition wire
- high spark plug wire resistance
- defective points
- bad vacuum leaks
- leaky exhaust valves; defective guides or lifters
- excessively rich or excessively lean mixtures
- low compression: defective rings, pistons, or cylinders

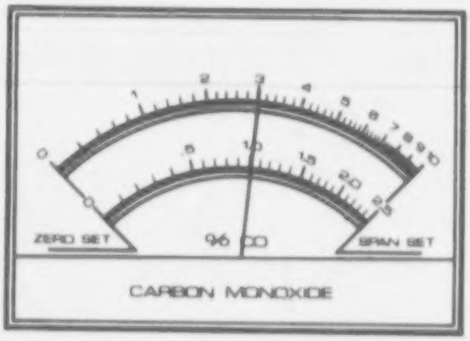
Figure 39-6 Hydrocarbon Readings Are Too High (600 ppm)



If the carbon monoxide test readings are too high (3 percent), as in Figure 39-7, they are a result of any restriction in the oxygen or air supply caused by:

- restricted or dirty air cleaner
- clogged or dirty air-mix passages in the carburetor
- a rich mixture jet adjustment on a carburetor
- a stuck or misadjusted choke valve or its mechanism
- restricted or inoperative PCV system
- improper idle speed

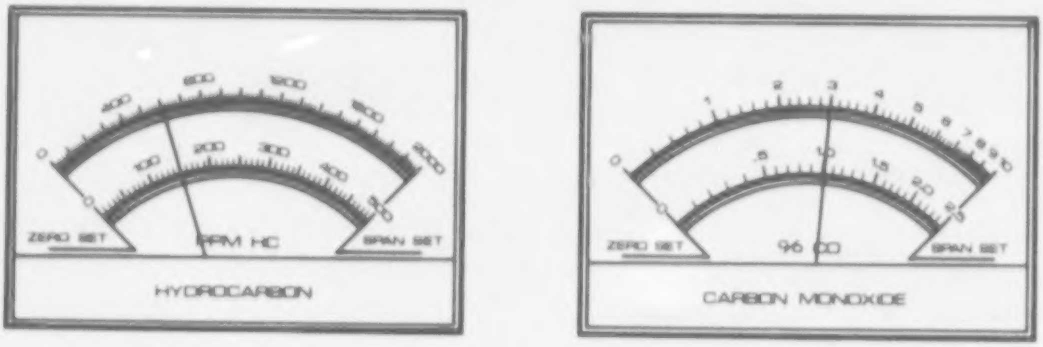
Figure 39-7 Carbon Monoxide Readings Are Too High (3%)


0
1
2
3
4
5
6
7
8
9
10
0
.5
1.0
1.5
2.0
2.5
ZERO SET
% CO
SPAN SET
CARBON MONOXIDE

If both hydrocarbon and carbon monoxide readings are higher than normal (see figure 39-8), they are caused by:

- inoperative PCV system
- a heat riser valve stuck open
- air pump malfunction or disconnection
- sticking air cleaner control damper assembly in the thermostatic air cleaner (TAC) system
- rich idle mixture, leaking needles and seats, leaky power valve, wrong float setting, faulty choke action

Figure 39-8 HC-CO Readings Are Too High


0
400
800
1200
1600
2000
0
100
200
300
400
500
ZERO SET
PPM HC
SPAN SET
HYDROCARBON
0
1
2
3
4
5
6
7
8
9
10
0
.5
1.0
1.5
2.0
2.5
ZERO SET
% CO
SPAN SET
CARBON MONOXIDE

Summary of Emission Test Results

Test Speed	READINGS		CAUSES
	HC	CO	
	HIGH	NORMAL	Poor ignition Leaky valves Low compression
	HIGH	LOW	Vacuum leak
IDLE	NORMAL	HIGH	Rich mixture Dirty air cleaner Restricted or inoperative PCV system Improper idle speed
	HIGH	HIGH	Inoperative PCV system Malfunctioning or disconnected air pump Carburetion mixture too rich

Turn to your Review Exercise Book and complete Exercise 22.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin any of the work activities until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

1. Warm up, calibrate, and hook up the HC-CO tester to a vehicle in preparation for testing the exhaust gas emissions (pages 184-86).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

2. Using the HC-CO tester, test the HC-CO exhaust levels of a vehicle. Write down the gauge readings, and analyze the test results (pages 187-90).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

After you have finished these activities, go on to the next section.

Carburetor Idle Adjustment

After you have made all the normal tune-up corrections and adjustments (spark plugs, secondary wires, contact points, timing, etc.), you need to make the carburetor idle and mixture adjustments to obtain the desired HC and CO emission levels. Before you make these emission control adjustments, be sure the tachometer and the exhaust emission tester are attached as before and that the carburetor air cleaner is completely installed. Then follow the steps given here.

Figure 39-9 Adjusting Carburetor Idle Speed and Mixture Screws

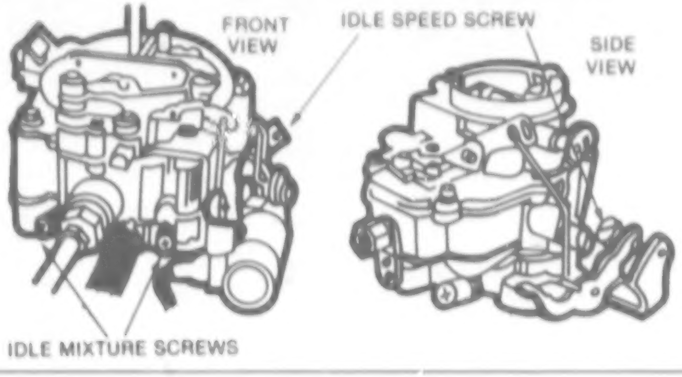
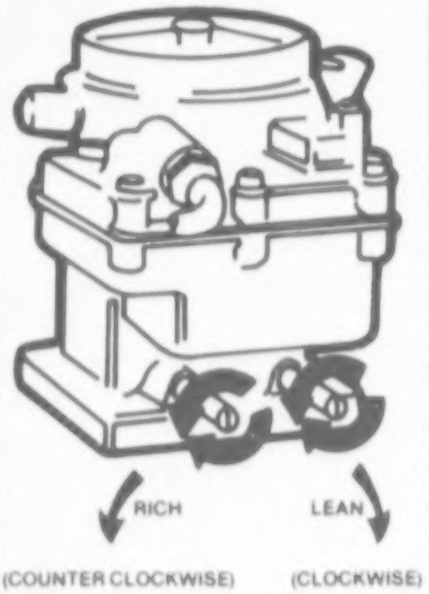


Figure 39-10 Adjusting Idle Mixture Screws


RICH
LEAN
(COUNTER CLOCKWISE)
(CLOCKWISE)

STEP 1 With the engine turned off, lightly seat the idle mixture adjusting screws (see figure 39-9).

STEP 2 Back out each mixture screw approximately 4 turns or, if the screws have internal stops, until you can't back them out any farther.

STEP 3 Start the engine and warm it up to normal operating temperatures.

STEP 4 Adjust the engine idle speed as specified by the manufacturer.

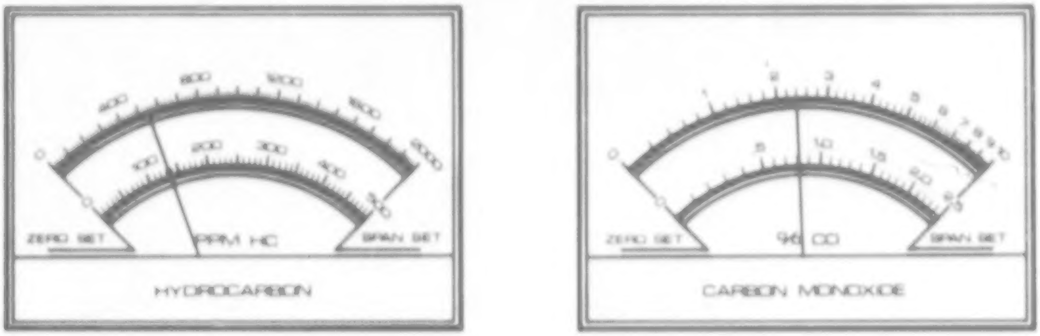
STEP 5 Gradually adjust the idle mixture screws equally to obtain the ***lowest HC reading*** and the smoothest idle (see figure 39-10).

STEP 6 Readjust the idle speed after each mixture adjustment as necessary to maintain the specified idle RPM.

STEP 7 Gradually adjust the idle mixture screws equally to obtain the ***lowest CO reading***, without increasing the HC reading.

The HC and CO readings should now be within the manufacturer's specification (or the legal limits), with the engine operating smoothly. Example: HC = 150 ppm, CO = 0.7 percent. (Read the lower scale in Figure 39-11).

Figure 39-11 HC-CO Levels Are within Specifications


0
400
800
1200
1600
2000
0
100
200
300
400
500
ZERO SET
PPM HC
SPAN SET
HYDROCARBON
0
1
2
3
4
5
6
7
8
9
10
0
.5
1.0
1.5
2.0
2.5
ZERO SET
% CO
SPAN SET
CARBON MONOXIDE

NOTE: If it takes longer than two minutes to make the idle adjustment, clean out the engine by operating it at 2000 RPM for a few seconds.

Testing Other Emission Control Systems with the HC-CO Tester

PCV system test. To determine if the PCV system is operating properly, follow the steps below:

STEP 1 With the engine idling, remove the PCV valve from the engine. Do not remove the valve from the hose (see figure 39-12).

STEP 2 Plug the open end of the valve and read the lower scale on the CO gauge (see figure 39-13).

GOOD If the CO reading increases, the PCV valve is working (see figure 38-13).

BAD If the CO reading remains the same or increases only slightly, the PCV valve is not working or the system is plugged.

Carburetor accelerator pump test. To determine if the accelerator is operating properly, follow these steps:

STEP 1 With the engine at normal idle speed, quickly open and release the throttle while looking at the CO gauge.

STEP 2 Note the reading on the lower scale of the CO gauge (see figure 39-14).

Figure 39-12 Removing PCV Valve from the Engine

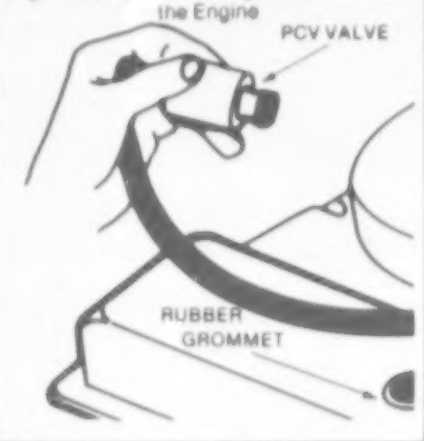

PCV VALVE
RUBBER GROMMET

Figure 39-13 CO Gauge Showing Increase in Carbon Monoxide Level

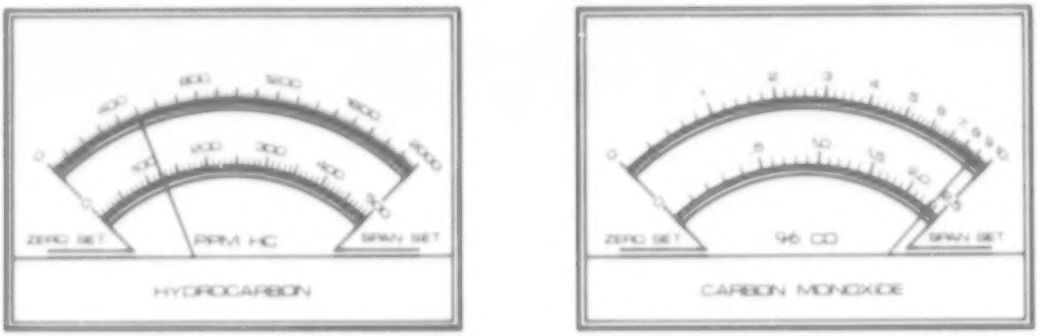
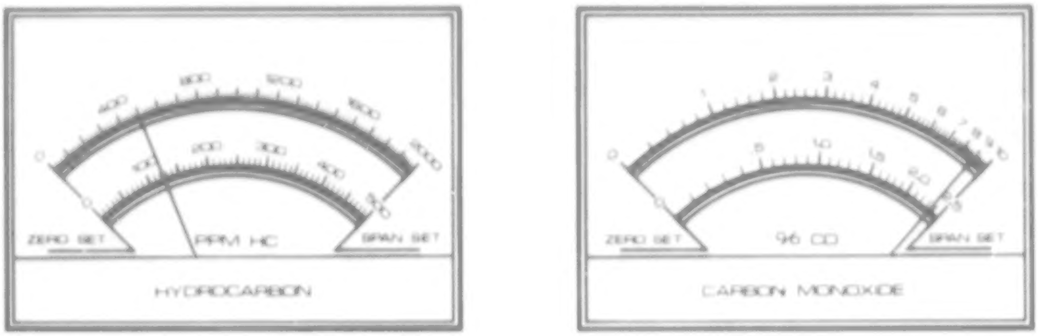

0
400
800
1200
1600
2000
0
100
200
300
400
500
ZERO SET
PPM HC
SPAN SET
HYDROCARBON
0
1
2
3
4
5
6
7
8
9
10
0
.5
1.0
1.5
2.0
2.5
ZERO SET
% CO
SPAN SET
CARBON MONOXIDE

Figure 39-14 Reading for Carburetor Accelerator Pump Test


0
400
800
1200
1600
2000
0
100
200
300
400
500
ZERO SET
PPM HC
SPAN SET
HYDROCARBON
0
1
2
3
4
5
6
7
8
9
10
0
.5
1.0
1.5
2.0
2.5
ZERO SET
% CO
SPAN SET
CARBON MONOXIDE

GOOD If the engine increases speed without hesitation, and the CO gauge reading increases, the carburetor accelerator pump is working satisfactorily.

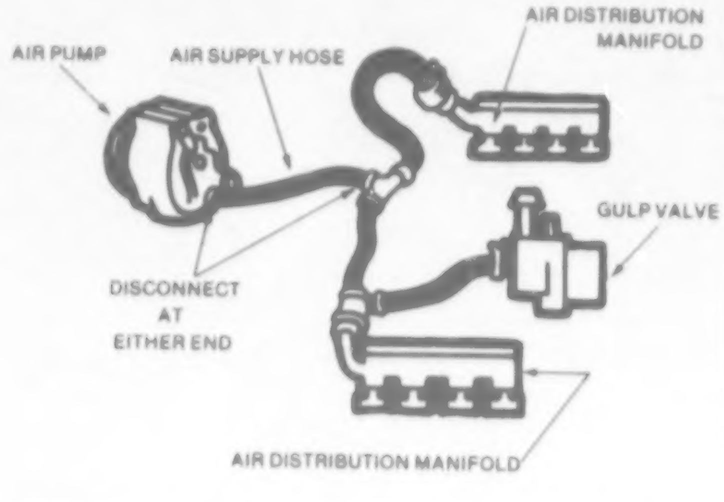
BAD If the CO reading decreases before it increases or does not increase at all, either the accelerator pump should be replaced or the pump linkage should be adjusted.

Air pump system test. To determine if the air pump system is operating properly, follow these steps:

STEP 1 Operate the engine at approximately 1000 RPM and note both the HC and CO gauge readings.

STEP 2 Maintaining the same engine speed, disconnect the main air supply hose leading from the air pump to the air distributor manifolds (see figure 39-15).

Figure 39-15 Disconnecting Main Air Supply Hose



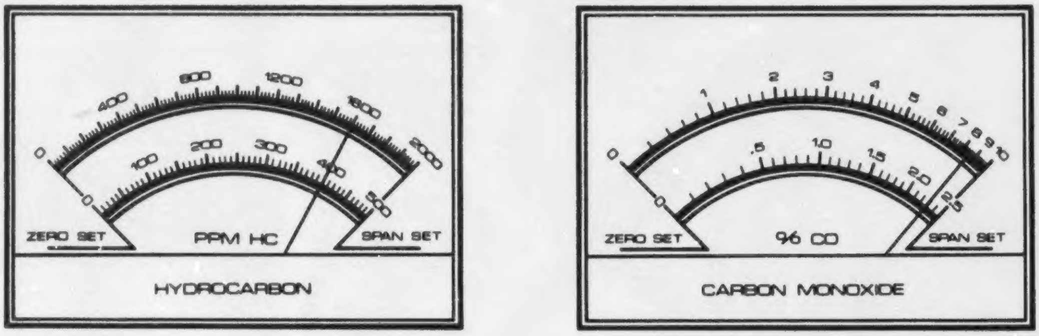
STEP 3 Note the lower scale for both the HC and CO gauge readings (see figure 39-16).

GOOD If the HC and CO readings increase, the air supply system is operating normally.

BAD If little or no increase in HC or CO readings takes place, make all necessary repairs and corrections on the air system.

STEP 4 After you complete the air pump test, reconnect the air supply hose.

Figure 39-16 Readings for Air Pump System Test


0
400
800
1200
1600
2000
0
100
200
300
400
500
ZERO SET
PPM HC
SPAN SET
HYDROCARBON
0
1
2
3
4
5
6
7
8
9
10
0
.5
1.0
1.5
2.0
2.5
ZERO SET
% CO
SPAN SET
CARBON MONOXIDE

Exhaust gas recirculation (EGR) system test. To determine if the EGR valve and system are operating properly, follow these steps:

STEP 1 Establish the HC-CO readings at idle speed.

STEP 2 Stop the engine. Remove the EGR valve and plug the vacuum-supply port in the intake manifold.

STEP 3 Start the engine and, with the engine operating at idle, look at the HC gauge reading.

GOOD If the HC gauge reading remains the same, no exhaust is leaking into the intake manifold.

BAD If the HC gauge reading is normal, an exhaust leakage in the intake manifold has been taking place.

Catalytic converter test. If the catalytic converter does not reduce HC and CO readings when everything else is set to specifications and when the reading taken at the tail pipe remains the same, the converter is not operating properly and should be replaced.

Turn to your Review Exercise Book and complete Exercise 23.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin any of the work activities until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

3. Using the HC-CO tester, adjust the carburetor idle mixture of a vehicle engine until it meets the manufacturer's specified HC and CO emission levels. Write down the HC-CO readings obtained (pages 191-92).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

4. Using the HC-CO tester, perform a PCV system test. Write down any difference in the CO reading obtained in your test results (pages 192-93).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

5. Using the HC-CO tester, perform an accelerator pump test. Write down any difference in the CO reading obtained in your test results (pages 193-94).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

6. Using the HC-CO tester, perform an air pump system test. Write down any differences in the HC and CO readings obtained in your test results (page 194).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

7. Using the HC-CO tester, perform an exhaust gas recirculation (EGR) system test. Write down any differences in HC readings obtained in your test results (page 195).

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

After you have finished these activities, go on to the next section.

Experimental Testing with the HC-CO Tester

The following experimental tests are included as work activities even though they are not directly related to an HC-CO engine exhaust analysis performed as part of a tune-up service. Doing these tests will increase your knowledge of exhaust performance analysis using the HC-CO tester. You'll learn what changes take place in HC and CO readings when various engine operating factors are altered.

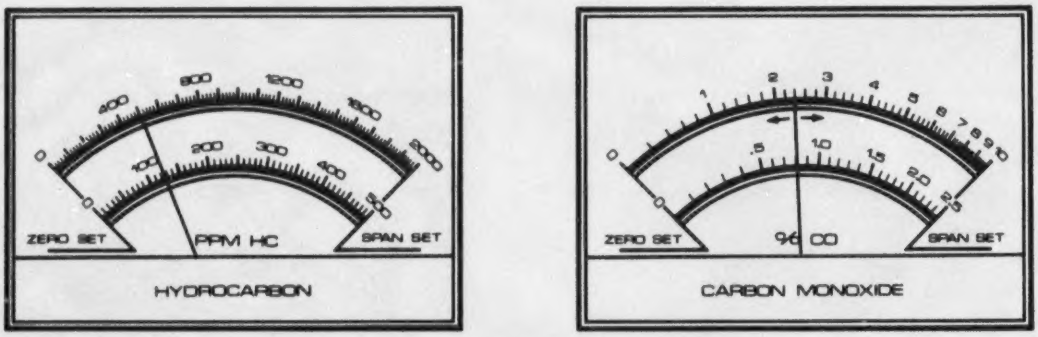
All tests (except where otherwise indicated) are to be made at idle with the engine at operating temperature and with the transmission in neutral.

NOTE: After completing each of the test experiments, reset the engine to the acceptable HC-CO levels you obtained in your previous carburetor idle speed and mixture adjustments.

Test 1: Idle Mixture (Figure 39-17)

- Back the idle mixture screw out exactly two turns from a slightly seated position. Note the gauge readings before and after you reset the screw.
- Turn the mixture screw one-half turn toward a rich mixture and note the gauge reading. Return the screw to its former setting.
- Turn the mixture screw one-half turn toward a lean mixture, and note the gauge readings. Return the screw to its original setting.
- How much difference does each half turn make in CO levels?

Figure 39-17

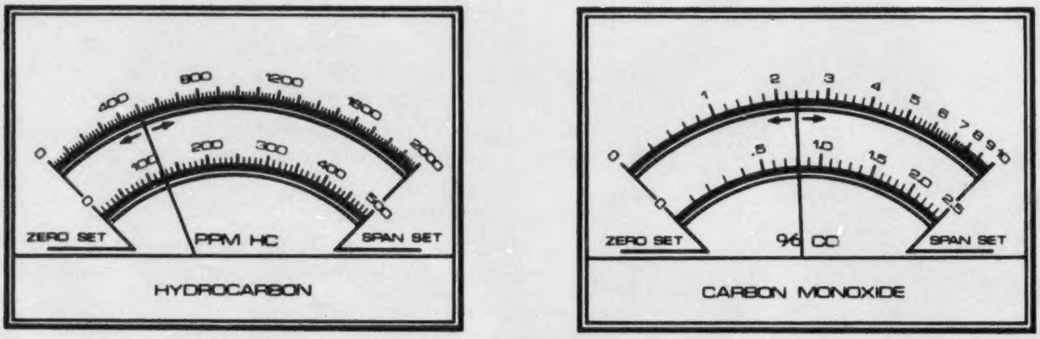


Test 2: Restricted Air Cleaner (Figure 39-18).

- While the engine is operating at idle, restrict the carburetor air inlet with your hand or with a piece of paper by covering about three-quarters of the opening. Observe any changes this causes on the gauge (read the lower scale).

- How much difference does it make in HC and CO levels?

Figure 39-18


0
400
800
1200
1600
2000
0
100
200
300
400
500
ZERO SET
PPM HC
SPAN SET
HYDROCARBON
0
1
2
3
4
5
6
7
8
9
10
0
.5
1.0
1.5
2.0
2.5
ZERO SET
% CO
SPAN SET
CARBON MONOXIDE

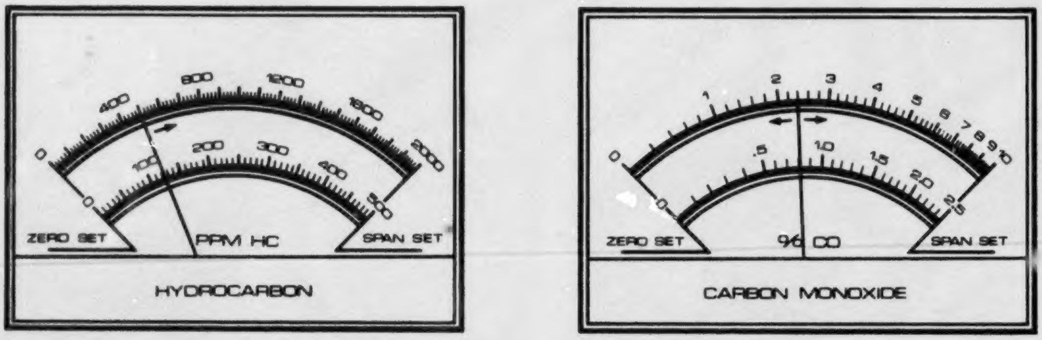
Test 3: Ignition Misfire (Figure 39-19)

- Disconnect a spark plug wire while the engine is idling. Observe any changes this causes on the gauge (read the lower scale).

CAUTION: If the vehicle is equipped with a catalytic converter, do not leave the spark plug wire disconnected longer than 30 seconds or the converter could be damaged.

- How much difference does it make in HC and CO levels?
- Do the same with another spark plug wire. Are the results the same?

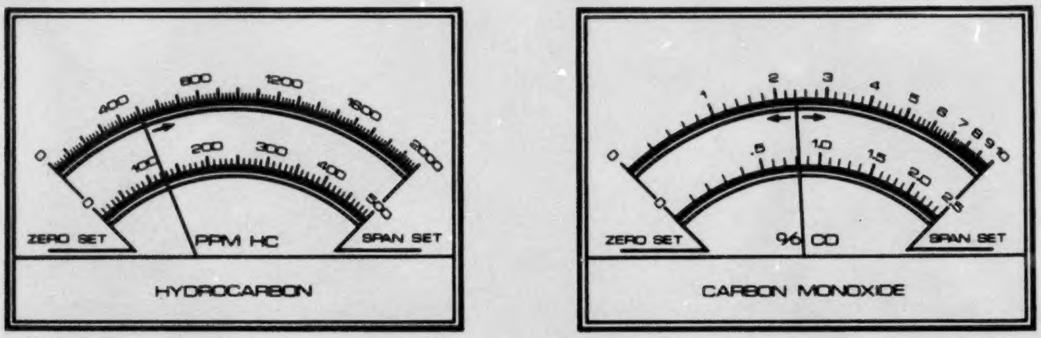
Figure 39-19


0
400
800
1200
1600
2000
0
100
200
300
400
500
ZERO SET
PPM HC
SPAN SET
HYDROCARBON
0
1
2
3
4
5
6
7
8
9
10
0
.5
1.0
1.5
2.0
2.5
ZERO SET
% CO
SPAN SET
CARBON MONOXIDE

Test 4: Crossed Spark Plug Wire (Figure 39-20)

- Cross-wire the first and second spark plugs on one bank of a V-8 engine. Notice the HC and CO gauges (use the lower scale).
- Cross-wire the third and fourth spark plugs on one bank of a V-8 engine. Notice the HC and CO gauge changes (use the lower scale).
- How much difference does the cross-wiring make in the HC and CO levels?

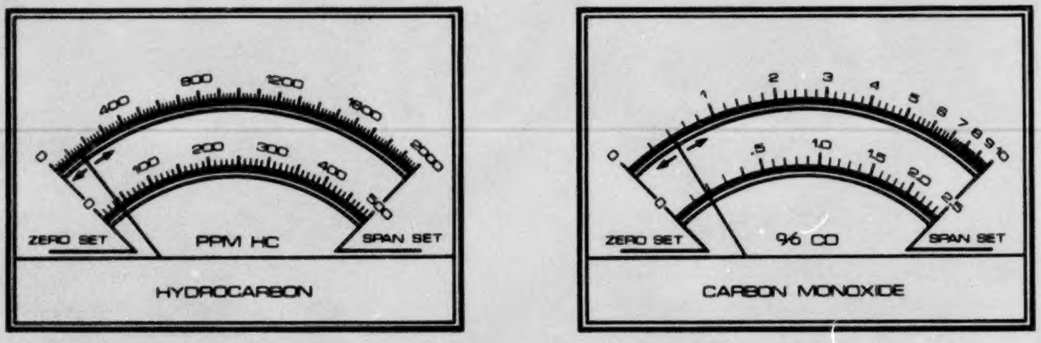
Figure 39-20


0
400
800
1200
1600
2000
0
100
200
300
400
500
ZERO SET
PPM HC
SPAN SET
HYDROCARBON
0
1
2
3
4
5
6
7
8
9
10
0
.5
1.0
1.5
2.0
2.5
ZERO SET
% CO
SPAN SET
CARBON MONOXIDE

Test 5: Spark Plug Gap (Figure 39-21)

- Remove the #1 and #2 spark plugs. Reset the gaps to .06 inches and reinstall them.
- Start the engine and notice the change in the HC and CO levels (read the higher scale).
- Remove the same spark plugs, reset the gaps to .015 inches, and reinstall them.
- Start the engine and notice the change in HC and CO levels.
- How much difference in HC and CO levels does spark plug gap setting make?

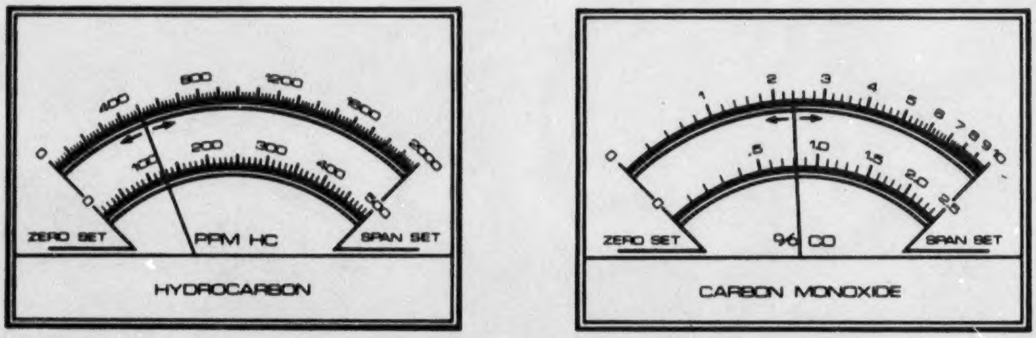
Figure 39-21


0
400
800
1200
1600
2000
0
100
200
300
400
500
ZERO SET
PPM HC
SPAN SET
HYDROCARBON
0
1
2
3
4
5
6
7
8
9
10
0
.5
1.0
1.5
2.0
2.5
ZERO SET
% CO
SPAN SET
CARBON MONOXIDE

Test 6: Vacuum Leak (Figure 39-22)

- Create a vacuum leak by removing the intake manifold hose from either a vacuum override temperature switch or the vacuum distributor modulator valve. Notice the change in HC and CO levels (read the lower scale).
- How much difference does a vacuum leak make in HC and CO levels?

Figure 39-22

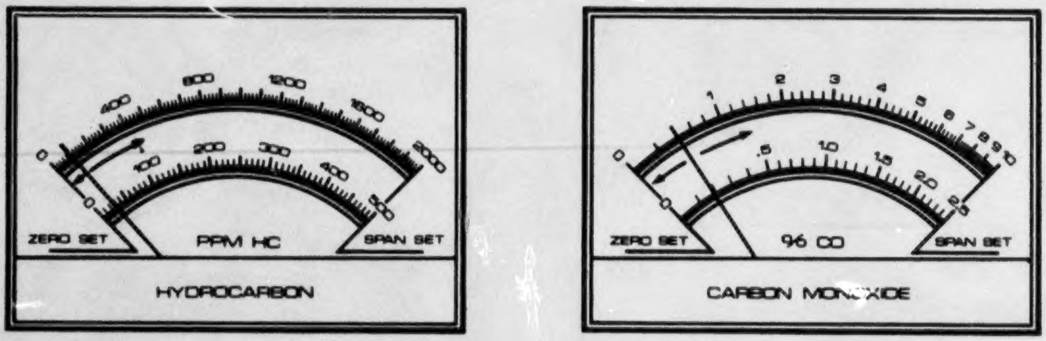

0
400
800
1200
1600
2000
0
100
200
300
400
500
ZERO SET
PPM HC
SPAN SET
HYDROCARBON
0
1
2
3
4
5
6
7
8
9
10
.5
1.0
1.5
2.0
2.5
ZERO SET
% CO
SPAN SET
CARBON MONOXIDE

Test 7: EGR Valve Test (Figure 39-23)

- With the engine idling, disconnect and, very quickly, reconnect the EGR vacuum hose at the EGR valve. Observe the gauge readings (read the higher scale).

  How much difference does disconnecting the EGR hose make in idle RPM and HC and CO levels? Repeat the EGR valve test while operating the engine at 2000 RPM. Notice the changes that take place in HC and CO levels.

Figure 39-23


0
400
800
1200
1600
2000
0
100
200
300
400
500
ZERO SET
PPM HC
SPAN SET
HYDROCARBON
0
1
2
3
4
5
6
7
8
9
10
.5
1.0
1.5
2.0
2.5
ZERO SET
% CO
SPAN SET
CARBON MONOXIDE

EXPERIMENTAL TESTS USING HC-CO TESTER

Before doing an experimental test, make sure you've learned all the information that comes before it in the Student Guide. If you need a review, read the information on the pages listed in parentheses next to each test. Do not begin any of the tests until you have your instructor's approval. If you're not sure that you can do an experimental test, ask your instructor for help.

1. Using the HC-CO tester, perform the experimental test of turning the idle mixture screws away from their settings (page 197). Draw the test reading changes on the HC-CO gauge diagrams located in your Review Exercise Book, page 129.

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

2. Using the HC-CO tester, perform the experimental test of restricting the carburetor air inlet (page 197). Draw the test reading changes on the HC-CO gauge diagrams located in your Review Exercise Book, page 129.

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

3. Using the HC-CO tester, perform the experimental test of disconnecting a spark plug wire (page 198). Draw the test reading changes on the HC-CO gauge diagrams located in your Review Exercise Book, page 130.

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

4. Using the HC-CO tester, perform the experimental test of crossing spark plug wires (page 199). Draw the test reading changes on the HC-CO gauge diagrams located in your Review Exercise Book, page 130.

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

5. Using the HC-CO tester, perform the experimental test of changing the spark plug gaps (page 199). Draw the test reading changes on the HC-CO gauge diagrams located in your Review Exercise Book, page 130.

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

6. Using the HC-CO tester, perform the experimental test of creating a vacuum leak (page 200). Draw the test reading changes on the HC-CO gauge diagrams located in your Review Exercise Book, page 131.

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

7. Using the HC-CO tester, perform the experimental test of disconnecting the EGR vacuum hose (page 200). Draw the test reading changes on the HC-CO gauge diagrams located in your Review Exercise Book, page 131.

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

When you have finished with these tests, ask your instructor to return your pretest on Performance Objective 39. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will tell you if you are ready to be checked off on the performance checklist or if you need to correct some of the answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor. After you have been satisfactorily checked off on the checklist, ask your instructor for the posttest for Unit 6.

The Tune-Up Service

You have now completed all six instructional units that make up Engine Tune-Up Service:

You are now ready to perform the final work activity for Engine Tune-up Service: a complete tune-up service on a vehicle engine. You should do as many tune-up services as time will permit. Repetition will give you practice in doing the procedures and using the equipment, as well as valuable experience in working with different engine makes and models.

REMEMBER: An engine tune-up service consists of two parts: ***Engine Performance Testing and the Diagnosis of Engine Malfunctions;*** and ***Adjustment, Repair, or Replacement of Defective Parts: the Tune-up Procedure.***

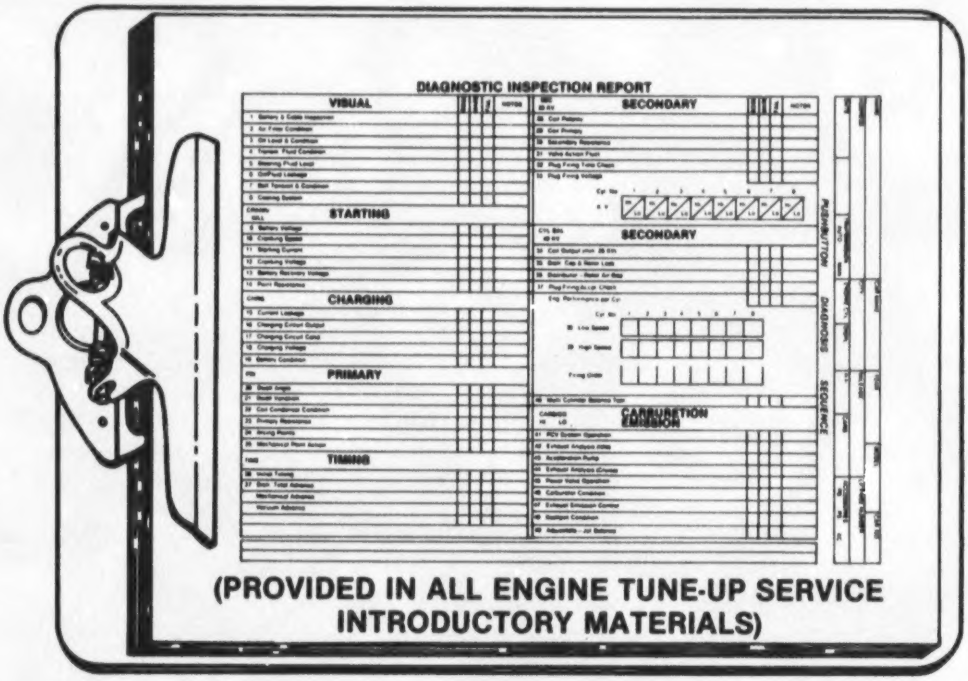
Courtesy Sun Electric Corporation

Engine Performance Testing and the Diagnosis of Engine Malfunctions

Your first step is to use the engine analyzer, scope, and exhaust emission tester to conduct the necessary tests for each of the six engine systems. The purpose is to make a complete diagnosis of engine malfunctions.

To help you do the tests in an organized manner and keep a record of your test findings, always use a Tune-up Inspection Report (see figure 39-24). Many types are in use and available in the automotive industry. For this course, however, use the inspection report given to you by your instructor.

Figure 39-24 Diagnostic Inspection Report



DIAGNOSTIC INSPECTION REPORT

VISUAL

STARTING

CHARGING

PRIMARY

TIMING

SECONDARY

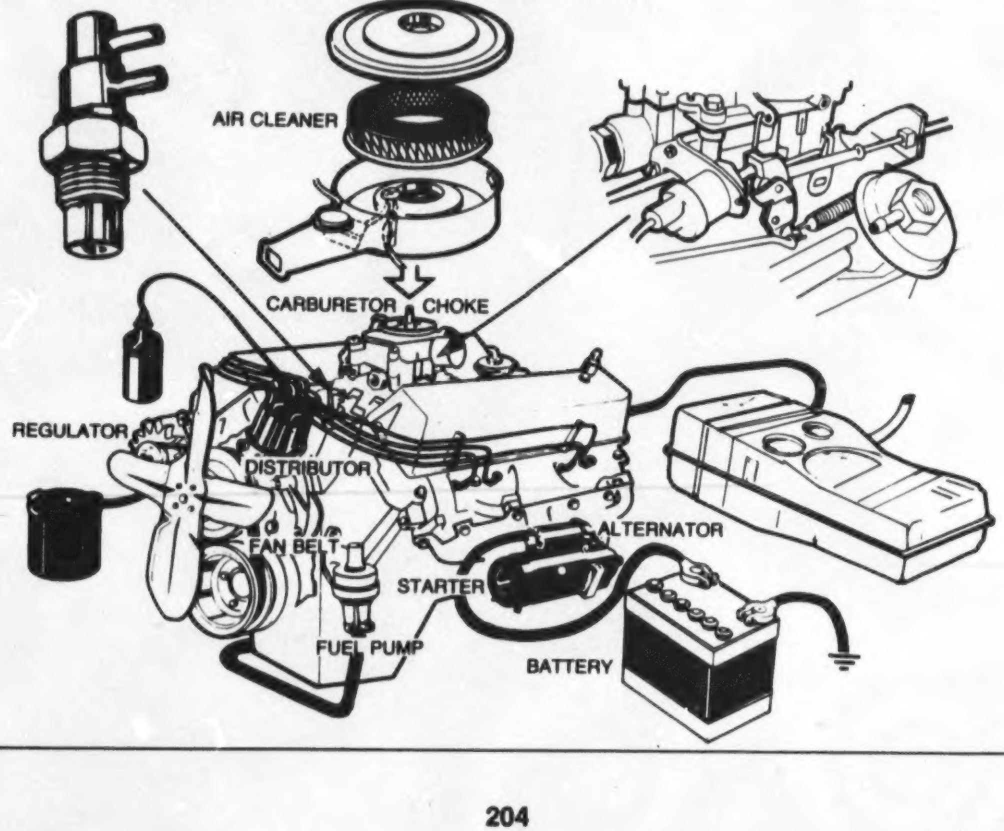
SECONDARY

CARBURETION EMISSION

PUSHBUTTON DIAGNOSIS SEQUENCE

(PROVIDED IN ALL ENGINE TUNE-UP SERVICE INTRODUCTORY MATERIALS)

Figure 39-25 Engine Components Involved in the Tune-Up Procedure


AIR CLEANER
CARBURETOR
CHOKE
REGULATOR
DISTRIBUTOR
ALTERNATOR
FAN BELT
STARTER
FUEL PUMP
BATTERY

Adjustment, repair, or replacement of defective parts

The tune-up corrections you perform should follow a logical order, with all the necessary replacements, repairs, or adjustments completed for one engine system at a time.

For example, organize the tune-up around the procedures you followed when you tested for engine malfunctions, starting with the corrections needed for the battery and cranking system (see figure 39-25):

- service the battery and cranking system
- service the charging system
- replace the points, condenser, rotor, and distributor cap (primary ignition services)
- replace the spark plugs and spark plug wiring (secondary ignition services)
- service the carburetor, air filter, fuel filter, PCV valve, heat riser, and automatic choke (fuel and carburetion systems)
- adjust the points (dwell)
- set the basic timing
- service the emission control systems and adjust the carburetor
- road test the vehicle

The last step in the tune-up procedure is to make a final check to be sure that all engine malfunctions have been corrected and that the engine performs without breakdown. Always check with your instructor when you are ready to road-test a vehicle: it is necessary in order to comply with your school's rules and regulations. If there is a chassis dynamometer available, you can check the road load engine performances in the shop instead of driving the vehicle on the highway.

WORK ACTIVITIES

Before doing this final work activity for Engine Tune-up Services, make sure you've learned all the information that comes before it in the Student Guide.

Do not begin this work activity until you have your instructor's approval. If you're not sure that you can do the work activity, ask your instructor for help.

*Perform a complete tune-up service on a vehicle engine, making sure that all adjustments meet the vehicle manufacturer's specifications.

CHECK YOUR WORK WITH YOUR INSTRUCTOR.

*This concludes Engine Tune-up Services.